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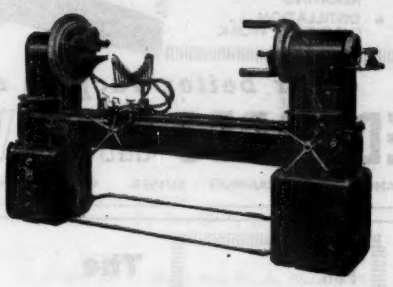

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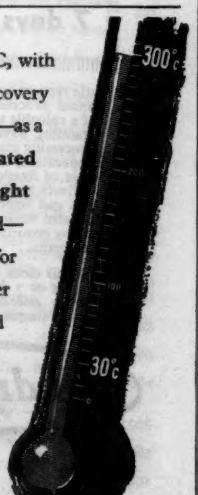

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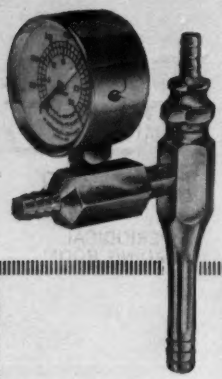

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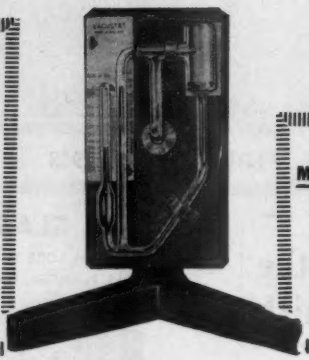

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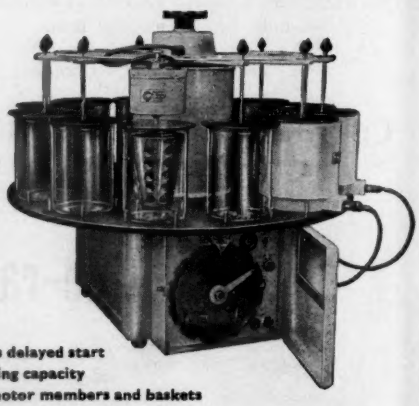

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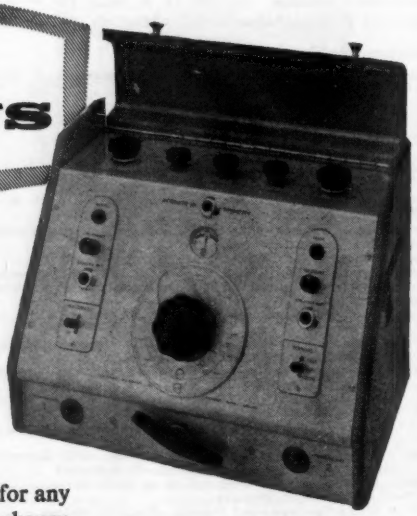

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MAN-POWER IN THE ATOMIC ENERGY AUTHORITY

IN its first annual report, published in October 1955, the Atomic Energy Authority discussed its difficulty in recruiting sufficient staff, particularly senior staff and the younger engineers and technicians needed to form the base of the pyramid to-day and to provide the leaders in years to come; it also recognized that inadequacy of staff is a constant threat to achievement of the Authority's programme and admitted frankly that, even if dates continued to be achieved, details might be skimped which would cause operating troubles in future. That report was written in the context of the nuclear power programme outlined in the White Paper of February 1955. Since then, as Lord Mills announced in February of last year, the programme has been further expanded to provide almost treble the capacity of nuclear power; and although it is not expected that the number of nuclear power stations originally contemplated will be increased, the demands made upon scientific and technical man-power for such accelerated development as well as for operating will be appreciably greater.

It is therefore scarcely surprising that the Committee set up by the Prime Minister, under Sir Alexander Fleck's chairmanship, to examine the organization of certain parts of the United Kingdom Atomic Energy Authority should conclude that the continuous pressure on the Authority's Industrial Group to take on new tasks has strained its resources to the utmost, and left those responsible for operating factories within the Group with insufficient technical staff and inadequate technical assistance*. The many and varied commitments of the Group are fully recognized and also its remarkable success in bearing the tremendous load piled upon it. None the less, there are limits to what can be achieved with limited man-power, and the Fleck Committee is clear that the weaknesses in the Group's present organization arise primarily and noticeably from an insufficiency of senior technical staff in the Operations Branch. The Committee was impressed by the speed and success with which the Industrial Group has been built up; but the Group's ever-widening commitments have left it considerably under-manned, particularly in the more senior posts. In consequence, those in charge of operating existing plant have had inadequate technical assistance and advice, while liaison between the various branches of the Group and with the Research and the Weapons Groups at Harwell and Aldermaston is poor. Such factors as these were emphasized by the Windscale accident, which led to the appointment of the Committee, as was recognized at the time by the chairman of the Authority, and the Committee rightly considers it is essential to remedy them.

The recommendations of the Committee in this connexion have implications which extend far beyond the activities of the Atomic Energy Authority itself; but before considering them, the Committee's full terms of reference should be noted. It was first to review the organization and staffing of the Operations Branch of the Industrial Group of the Atomic Energy Authority and to make any recommendations necessary to ensure that the Branch is able adequately to discharge its responsibilities. It was to review similarly the staff engaged on the operation of reactors in the Authority's Research Group. It was to review the relation of the Operations Branch to the other branches and directorates of the Industrial Group and to the technical advisers in the Research Group, and to make any recommendations necessary to ensure that this relation is the one that best enables the Operations Branch to fulfil its functions, and that the division of responsibility between these various parts of the Authority is clearly defined. The relation of the staff engaged on the operation of reactors in the Research Group to other parts of organization was to be reviewed similarly.

The report begins by outlining general principles which the Committee considers should guide the organization of a large technological production group and then reviews the development of the Industrial Group and its present organization. On this basis are formulated the proposals for the reorganization of the Industrial Group Headquarters and for the reorganization at the works, and recommendations regarding the duties of the technical sections of the Operations Branch, the operation of reactors in the Research Group, and the special problems of Dounreay. Although in these latter respects the report enters into more detail than that of the Advisory Committee on the Organization of the Coal Board, it can fairly be placed with that report as an outstanding paper on administrative management, as well as one of profound importance for the efficient and economic use of scientific and technical man-power in general.

The Committee summarizes the present position in the Operations Branch by suggesting that the Branch has become seriously out of balance with the Engineering and the Research and Development Branches, and it insists that nothing should interfere with the provision of adequate staff, both for the safe and efficient operation of existing plant, and the development of completely safe and efficient plant for the nuclear power programme. These are the primary tasks of the Industrial Group, and the Committee points out that to ensure that the first stations for the nuclear power programme are designed and

* Report of the Committee appointed by the Prime Minister to examine the Organization of certain parts of the United Kingdom Atomic Energy Authority. Pp. 40. (Cmnd. 338.) (London: H.M. Stationery Office, 1957.) 2s. net.

operated with the maximum efficiency and safety requires that those responsible for design, construction and subsequent operation have the benefit of full advice from the whole of the Authority, as well as full information based on the experience gained by the Industrial Group in operating its own reactors. The advancement of new techniques, while of high national importance, is secondary to this; and the Committee considers that should it become necessary to concentrate the Authority's development effort on fewer projects; this must be accepted as an inevitable consequence of the national shortage of suitably qualified technical staff.

The Committee is clearly right in this view; but before considering its various implications, the recommendations may be briefly noted. First, as regards the headquarters of the Industrial Group, no major change in the organization of the Group is recommended; after stressing the paramount importance of the two major tasks already indicated, the Committee emphasizes the importance of the principle of collective responsibility of board members and the vital role of the personnel branch in advanced technological work of the character on which the Group is engaged. A sound policy of recruitment, training and promotion of technical staff is so important that the director of personnel should be recognized as holding a key position in the organization, and in particular he should be responsible for ensuring that the available technical staff are distributed so as to ensure the proper functioning of the Group as a whole. It is also suggested that it should be his duty to press within the Authority for an active policy on staff recruitment, training and the interchange of staff.

The changes recommended with such conditions in mind are designed to give more time to think. Appointment of two deputy managing directors to assist the managing director, and, like him, substantially free from routine duties, is the first recommendation. Next, the board of management should include a director, appointed for a limited period and chosen for his scientific ability, specifically responsible for ensuring liaison with other Groups and appropriate external bodies, as well as a few visiting members from other Groups. In the detailed proposals for re-organizing the headquarters of the Operations Branch, stress is laid upon the importance of the senior posts being occupied by men of proved technical ability, while the need to strengthen the Administration Branch, which should be renamed Personnel and Administration Branch and its status enhanced, is also recognized. A new director, with a seat on the Board, should be appointed to take charge of the Dounreay site, while a review of the committee's structure relating to Industrial Group operations is also recommended.

The responsibilities of the director of the new Health and Safety Branch will be discussed fully in the report of the Health and Safety Committee, the third of the three Committees appointed by the Prime Minister following the Windscale accident; they are briefly summarized in this report as providing supervisory services both to the health and safety organizations at the works and to the Engineering and Research Development Branches in the design of all new plant and installations. At the works level, the Committee recommends that the existing practice of appointing works general managers to the major establishments, supported by works managers responsible for individual plants, should be continued. In particular, a separate works general manager, responsible direct to headquarters, should be appointed for Chapelcross. Emphasis is again laid on the importance of clearly laying down the chain of command at the works, and of encouraging interchange of staff between the Operations Branch and the Engineering and Research and Development Branches and the other Groups of the Authority; and it is pointed out that a works general manager should himself be a good technologist, and that the number of scientists and technologists available to him should be substantially increased.

The organization at the Research Group responsible for the operation of reactors is regarded as correct in principle and adequate for the present purposes; but it will require constant review as the complexities of the reactors operated by the Group increases. Besides the creation of a new post of director of Dounreay, as already noted, the Committee recommends that the functioning of this site should be reviewed in two or three years time, and it suggests that this experience may be of great value when the Winfrith Heath organization is being considered. Further, it suggests that the Authority should carefully review the time-scale and staffing problems of the Dounreay project in the light of its other commitments, and it points out that the very high fuel ratings of the fast reactor and the nature of the other facilities at Dounreay call for exceptional technical competence in its management.

These proposals involve the creation of numerous new senior technical posts, and although the filling of such posts is a matter for the Authority and not for the Committee, the latter recognizes that some of the posts can only be filled by transfer, and that time will be required to make such transfers and the related adjustments. None the less, it is emphatic that the posts must be created and filled, even if this necessitates some curtailment of the work at present being done. Nothing must interfere with the provision of adequate staff, both for the safe and efficient operation of existing plant and the development of completely safe and efficient plant for the nuclear power programme.

It is obvious that the Fleck Committee is not optimistic about the prospect of the Authority recruiting in the near future the substantial number of highly qualified men it requires to fill these new senior posts and to strengthen the technical staff of the Operations Branch at a lower level. It is possible that the Fleck Committee is too optimistic as to the possibility—or practicability—of finding the men from within the organization. Personal qualities and preferences can be a decisive factor in determining the choice of a post by a scientist or technologist,

quite as much as ability; and it should not be assumed too readily that those who find satisfaction in research and advanced development at Harwell or Risley will necessarily be attracted to running a production plant. There are, moreover, the actual conditions to be considered: isolation itself will be a deterring factor to those keen on technical progress or creative work, unless a good deal of care is taken to offset such disadvantages as are inherent in sites like Dounreay.

The Fleck Committee does not doubt that, given the right leadership, the business of plant operation can be made attractive to highly qualified men, and it suggests that such posts may well become a good recruiting ground for men with both technical background and ability and some experience in management. None the less, it is fully alive to the plain truth that, on the whole, industry pays its men better; and that the Government decision that salaries of senior staff should not be seriously out of scale with those paid by public corporations, and the inheritance of a Civil Service grading structure, may continue to hinder both the recruitment from within established industry of sufficient senior staff and the grading of scientific and technical staff so as to cause the minimum obstacles to movement. The present difficulties will scarcely be settled so easily, and they demonstrate once more the relation of the whole problem to an adequate supply of scientific and technical man-power, to the esteem and status accorded to the technologist and to the far-reaching effects of a really adequate system of selection and training for the highest managerial positions.

Very clearly, although the problems lay outside the survey of the Fleck Committee, the Atomic Energy Authority cannot leave the matter there. It must reconsider its whole organization from the level of the main Board downwards. Only in the light of decisions as to the extent of its ever-growing responsibilities and what responsibilities in the long run can be transferred to industry or to other public bodies is a clear idea possible as to the magnitude and balance of the staff it needs.

The greatest importance of the report may well lie, however, in the wider implications that arise in this connexion. First, it is a convincing demonstration of the dependence of Britain's economic and industrial development upon the condition of scientific and technological education. It is our neglect to attend to this that is responsible for the present handicap under which the Atomic Energy Authority labours and which may cause us to miss some of the opportunities now opening to us.

Secondly, such weaknesses in education cannot be remedied quickly, but require the study and imaginative pursuit of a long-term policy, not only in educational circles but also in industry. Moreover, the report indicates once more that such a policy is unlikely to be formulated and implemented in industry, or for that matter in Government circles, unless there are men at the board and other high administrative levels who have themselves scientific and technical experience as well as vision and sound judgment. Such men are unlikely to be found in these positions except as a result of deliberate policy involving the careful search for talent and its selection, testing and training from early years. The extent to which the Government and industry in general ponder and apply the lessons to be learnt from this report, and bring a new understanding and urgency to the expansion of technological education, and to the selection and training of managers and administrators, will determine the speed with which the present difficulties of trained man-power which hinder the progress of Britain's nuclear power programme will be relieved—either by an increased intake at lower levels from the universities or colleges of technology, or at more senior levels from elsewhere in industry.

The key factor is management, for the best hope of providing the conditions most likely to attract the highly skilled scientists and technologists and to encourage them to give of their best depends on wise, resourceful and imaginative management. It is such management again that will minimize the shortage by seeing that such skilled man-power is adequately supported by technicians, craftsmen and clerical assistance, and that it is not wasted on tasks that could be done as efficiently or even better by less highly trained workers. It will be alert to eliminate misunderstandings and to check any tendency to disparage a post and so deter people from filling it; and in this matter of status, management will need, and should receive, the full support of all those who appreciate the nature and worth of the work of the scientist, the technologist and the technician in industry. The Fleck report could provide an admirable text for lecturers in the new programme of activities which the British Association has announced.

BREWING

A Textbook of Brewing

Vol. 1. By Prof. Jean de Clerck. Translated by Kathleen Barton-Wright. Pp. xx+587. (London: Chapman and Hall, Ltd., 1957.) 84*s*. net.

OF the two volumes which this translation will comprise, the present one is concerned primarily with the various sections of the brewing process, including malting, and with commercial equipment for that purpose, but it rightly incorporates considerable discussion and numerous references to relevant topics in pure science. A reviewer soon becomes keenly aware, as he reads this book, of the wide scholarship and great achievement of the author when in 1948 in the original French edition he brought together so many diverse facts and opinions from the different worlds of science and commercial brewing. In the present instance, a reviewer must indeed attempt to see the outcome from at least four points of view; in short he must regard the book as a text-book of brewing, as a contribution to science, as a translation and lastly as an attempt on the part of the translator to bring the original text up to date.

Clearly it would not be reasonable to expect this to be a text-book of brewing in the sense that it

might take the place of practical experience. The object of the author has rather been to add to a general account of brewing practice a discussion of various modifications adopted in the major beer-producing countries of the world, and indeed the comparative differences encountered in malting and brewing procedure form a valuable feature of the book. The emphasis is, perhaps naturally, on Continental practice, and, although British and American usage is not forgotten, the unwary reader could sometimes be misled. For example, even remembering the possible injustice of quoting isolated statements, the assertion that in Great Britain certain types of wood are used as fuel in kilning malt so that the smoke may impart a special flavour is literally true but is scarcely a fair summary of British methods. As a translation the English version of the brewing sections is in every way excellent; practically no indications remain of the original having been in French. Valuable efforts have been made to bring the technical aspects up to date. In particular the section on malting is notable because of the paucity of modern texts on this topic, while other chapters like those on filtration and bottling will also be generally welcomed. Perhaps some readers will expect a rather less superficial and descriptive approach or will be disappointed that certain aspects, such as the formation of haze in beer and the related topics of the amount of air included with bottled beer, have not received the detailed critical appraisal which they would often seem to demand.

Turning to scientific content, the account is primarily factual and, probably unavoidably, gives much weight to empirical rules which are sometimes based on little or no scientific evidence. For example, hand evaluation of barley is said to lead only rarely to mistakes, but obviously this can be justified only by experience of those relatively few varieties which have been under long observation, and it does not necessarily apply to new hybrids such as are now commonly grown and which have been developed for special characteristics. Again, the unwary reader could sometimes be misled, perhaps to some extent as a result of restriction of space. Thus on p. 60 an erroneous structure is given for colupulone, it is wrongly stated that humulone and lupulone are derivatives of quinone, while in some respects the discussion of hard and soft resins of hops is scarcely consonant with modern thought on this topic. It must be added that these considerations mostly arise in connexion with recent advances in rapidly moving subjects, and that they arise at all must be set against the fact that recent work on the science of brewing, especially since the Second World War, has been more exhaustively covered than technical advances over the same period. These are, in any event, only minor deficiencies, for the main object of the book is not to turn the scientist into a brewer but to explain to the latter something of the scientific basis of his craft so that technical improvements can be devised more surely than by guesswork alone. If that basis were to concern one department of science alone, the task would have been formidable enough. Actually it involves many quite widely separated sciences such as agronomy, structural organic chemistry, colloid chemistry and the genetics of micro-organisms, to mention only a few. It is the more remarkable, therefore, that the author and translator have jointly succeeded in producing the most comprehensive international work of its kind to have appeared for a long time.

A. H. Cook

DEMOGRAPHY OF AN UNDER-DEVELOPED TERRITORY

The Population of Jamaica

By George W. Roberts. Pp. xxii+356. (Cambridge: At the University Press, 1957. Published for the Conservation Foundation.) 40s. net.

A NOTABLE feature of the progress of demography in recent years has been the increasing attention paid to the under-developed—that is, poor and relatively non-industrial—territories. Typically, these have a high birth-rate and a mortality which is decreasing owing to famine control and improved hygiene and medical services. As a consequence, there is steady, and often rapid, population growth which is a major factor in any attempts to raise living standards. Only a few full-length studies of such areas have appeared, and this account of the demographic history of Jamaica is an important addition to their number. It was written as part of a research project sponsored by the Conservation Foundation, an American organization formed to promote knowledge of the Earth's resources, and is the first of three reports on Jamaica's population problems. The others are to be about a field study of family relationships and attitudes as they affect reproduction and the use of land and resources, respectively.

In some ways Jamaica is a particularly useful choice for such a study. The population of one and a half million is sufficiently homogeneous for the overall demographic characteristics to have meaning. A further advantage is the existence of fairly early records. In addition, the main trends are of almost text-book form. Fertility has been stable and fairly high over a long period but is now declining, while mortality has fallen steeply since about 1920; the rapid population growth is associated with serious unemployment. Mr. Roberts has made a very thorough study of the demography of the island from the early eighteenth century to the present day. Most of the data on which the account is based come from censuses (held since 1844) and birth and death registration, but other records, particularly for the earlier periods, are used skilfully, including those relating to importations of slaves and indentured labour. The nine chapters of the book are divided in the following way. After an opening chapter on the demographic material there are one each on the growth of population and its major characteristics, two on migration, one on mortality and two covering the inter-linked subjects of fertility, mating and reproduction. The final chapter gives some projections of the population up to 1971. Throughout, considerable attention is paid to details for regions, as well as for the island as a whole, particularly in relation to urban development.

Data for studies of this kind are always faulty and incomplete and one of the main criteria of their merits is how these difficulties have been handled. The book is very strong here. Wherever possible, the accuracy of records is cross-checked and a number of ingenious methods of analysis are applied. Interesting use is made of the survivorship table approach to illuminate problems. Mr. Roberts's judgment is always sound, but in a few places his close knowledge of Jamaican conditions leads him to tentative explanations which are not too convincing since they are a product of personal experience rather than of the evidence presented. He never, however, confuses

speculation with reasoned conclusion. The discussions and presentation are clear, but some of the descriptions of analysis techniques are too cursory, and careful reading is needed to determine exactly how they were applied and the assumptions made.

The records for Jamaica have the great advantage of fair accuracy but, in many respects, they are very limited. In particular, there is little break-down of the number of births and child deaths by the characteristics of the parents. Thus no close study of differentials in fertility and mortality—the most satisfactory approach in the search for causes—is possible. This is a serious restriction, notably in connexion with the complex pattern of mating which involves 'keeper' unions and consensual and legal marriages; here differentials can only be guessed at by indirect means. It seems possible, then, that the weaknesses of the basic material will greatly reduce in scope the studies of further aspects of Jamaican demography. Some small-scale sample surveys of the mating and reproductive histories of women would surely give results of enormous value in this area.

W. BRASS

A BROAD VIEW OF ECOLOGY

Agricultural Ecology

By Prof. Girolamo Azzi. Pp. xv+424. (London: Constable and Co., Ltd., 1956.) 45*s*.

THE ecology of agricultural crops is a subject which is well worked and yet little known. There is a mass of undigested information about an enormous range of crops. In fact, much more is available than for wild plants, which are the plants with which ecologists usually deal. For this reason, a new book is very welcome, especially so since it is written by someone who has been intimately connected with the subject for thirty-five years.

With such a wide field it would be possible to write a safe, factual, rather prosaic book. However, Prof. Azzi has preferred to write differently. "Agricultural Ecology" is a book of imaginative ideas, around which is woven a considerable amount of information, most of which has not been available in English before. While to some Prof. Azzi's treatment may be annoying, it is both stimulating and provoking, and sorts out some of the tangle of factors affecting the growth of plants in the field.

The author begins with climate. Looking at it from the point of view of the plant, he shows very clearly the division of the growth of plants into periods. As the plant passes from one period to another, so its climatic needs—cold, heat, water, etc.—vary. In each period a different factor is critical and may be limiting to growth and final yield. A mass of data is given for a considerable variety of crops, both tropical and temperate, and it includes critical estimates of crop needs in each period. Of particular interest are the figures for rainfall need and the passing references to the critical factors concerned in such things as different as wheat rust and cotton boll weevil.

With the help of the critical factor concept, the normal maps of climatic factors are converted into maps of crop physiographic zones, and polygon figures combining factors together are used for representing crop climatic ranges diagrammatically.

Soil is treated in the same cavalier but provoking fashion. Soils are classified on the basis of an index derived from chemical content, water balance and workability, and not on a more classical pedological basis. As a result, it is possible to correlate productivity with soil characteristics.

The last part of the book is concerned with the yield of the plant as such, and its relation to specific ecological factors. Quality is linked to quantity, and seed quality and the effects of vernalization are not forgotten. Out of it all Prof. Azzi develops a general concept of the inter-relations of velocity of growth, size and structure of crop plants, and again he is able to relate it to productivity.

Here then is a curious book, both delightful and infuriating. The publishers say that it is the definitive text-book in agricultural ecology. I cannot agree with them. In one romantic sweep, Prof. Azzi has turned inside out every conceivable aspect of the growth of plants. He has thrown on one side almost every traditional approach, omits almost completely references to work published in English, and makes no use of statistics. Many will think his ideas are not so proper as classical ones. Yet perhaps they are nearer to fundamentals. It is remarkable but true that we still know very little about crop yields and that most of us are content to accept variations in yield as we find them or to explain them piecemeal in terms of individual factors. Prof. Azzi is not. Perhaps his book will stimulate others to enter this field and to continue his good work.

A. D. BRADSHAW

WOMEN GRADUATES

Wives Who Went to College

By Judith Hubback. Pp. viii+164. (London: William Heinemann, Ltd., 1957.) 12*s*. 6*d*. net.

WOMEN who have had a university education want to use their capacities to the full and to make a contribution to society. How can they combine this with marriage and motherhood? Mrs. Judith Hubback, herself a graduate mother, tried to find this out by sending out, in 1953, a questionnaire to 2,000 married women graduates (of whom 58 per cent replied) asking about their types of training, marital status, domestic and social circumstances, number of children, incomes, professional careers and their state of overtiredness or satisfaction. She wanted facts to refute prejudice and to establish whether these women were actually mis-employed, what types of part-time work they followed and what form of education really intelligent girls should be given. As a control, 420 non-graduate wives with a similar social background were asked the same questions.

The first account of this research, financed partly by the Leche Charity, appeared as a Political and Economic Planning broadsheet entitled "Graduate Wives". The present book analyses the answers and discusses the issues raised. It is found that the marriage-rate for women graduates is almost up to the normal, that they tend to be more fertile than average, that it takes some fifteen years before the last child is at school, that circumstances during the period of raising children give little opportunity for systematic intellectual pursuits or for an outside career, but that part-time teaching is the career most easily combined with family life, although many other paid or voluntary occupations are followed by some of the sample. At the time of the survey 64 per cent are at home full-time, but a large proportion of the graduates intend to follow a career later, in

contrast to the control group. A whole chapter is devoted to overtiredness, due to diffuse, routine domestic work, which leads to frustration, and it is found that work outside the home, even part-time, results in a freshness of outlook and not in extra fatigue.

In the discussion, the need is stressed for a sane compromise between the biological aspects of a woman's life, as a mother carrying on the race, and the intellectual side developed by a university education.

It is suggested that modern emphasis should be on the diversity, rather than the identity of the sexes, and that a girl's education should enable her to evolve from the exclusive femaleness of the family stage, where, however, intelligence is not wasted, to the fulfilment of a wider personality later in life, given sufficient stamina, patience and a sense of proportion.

Practical issues are dealt with, and it is shown that the effect of the change in the balance of the population from a surplus of women to a surplus of men with the present early marriage-rate will lead within the next twenty years to a shortage of unmarried women of professional status, so that it will be more and more necessary to adapt conditions to the employment of married women. One essential change will be in the system of assessing income-tax paid by a married woman.

By collecting actual facts, Mrs. Hubback has done valuable work in raising this subject one step above the surmise and prejudice usually associated with it. From the trends observed, although the sample is small and not claimed to be statistically perfect, she draws valuable information leading to the conclusion that, while admitting the educational dilemma due to her probably dual role in life, an intelligent girl should be educated to the highest level of which she, as an individual, is capable and that she should continue her education to qualify for professional status. Because the author herself and the majority of her sample are at the family-raising stage she puts, perhaps, too low a value on the potentialities of highly educated women. It would be interesting and possibly more encouraging to career-minded girl students to have a further survey of the careers followed at the next stage, later in life, when so many professionally trained married women are tending to return to outside work.

C. E. Arregger

THE SCIENCE OF COSMETICS

Cosmetics

Science and Technology. Edited by Edward Sagarin. Pp. xix+1433. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1957.) 25 dollars.

THE avowed intention of the editors of this volume is "to bring together a number of authorities each of whom has acquired a thorough familiarity with some special phase of cosmetics or of some related science or technique". In this object they appear to have succeeded since sixty-one men and women have written fifty-three chapters covering the whole range of cosmetics.

This very large quantity of material is subdivided into five parts: 1, The Scope of Cosmetics; 2, Toilet Preparations; 3, Manufacture and Technology; 4, Physiological Considerations; 5, Legal Considerations.

Part 1 includes a chapter on the origin and development of cosmetic science from the days of the Egyptian and Babylonian Dynasties until the nineteenth century when the basis of modern cosmetic formulation begins to appear.

The major part of the book is to be found in Part 2. Fifty types of cosmetic preparations are grouped into thirty-five chapters, two or more allied preparations being incorporated together in some chapters. Each chapter is prefaced by a discussion of the requirements of the preparation to be compounded. This discussion involves a consideration of pharmacology, of presentation and of storage problems.

A lengthy chapter is included on aerosol cosmetics. This contains a discussion on the various types of propellants, the advantages and disadvantages of each, with numerous graphs showing the vapour pressures of various mixtures of these propellants. Types of containers and production methods are also considered. The chapter also includes a glossary of terms used in the aerosol industry—terms approved by the Chemical Specialities Manufacturers Association.

The numerous and varied formulæ are well set out in the text with the reasons for the inclusion or exclusion of any particular ingredient. Manufacturing instructions are given for nearly every formula, and where they are not included they can be deduced from similar formulæ.

Part 3 includes a very useful chapter on quality control emphasizing the necessity of statistical analysis. The subject of statistics is treated in as simple a manner as possible—formulæ are given but not proved. Consideration is given to the standard deviation, the Student t test, confidence limits, correlation and regression lines, analysis of variance. Useful information on the design of experiments is supplied.

Part 4 includes chapters on "The Physiology of Olfaction", "Hormones in Cosmetics" and "Sensitivity Testing". Part 5 includes a chapter on American patents and trade marks and a copy of the relevant parts of the Federal Food, Drug and Cosmetic Act, 1955.

The editing of the book has been extremely good, and little overlapping of information occurs in its many chapters. Each chapter is fully and widely referenced. The theoretical knowledge given, where it is required in each chapter, is generally good, although occasionally it is a little ambiguous when emulsions are being considered, but as the book is essentially one of cosmetic practice, these statements do not interfere with its usefulness.

The line diagrams are clear and well annotated; the graphs and tables self-explanatory. The photographs are good, although pictures of large-scale plant are not very enlightening. In the photographs of the mineral oil emulsions, two reference letters are missing.

An index of trade names is given, including details of chemical composition and manufacturers' names and addresses. The author index appears to be complete and is certainly well cross-referenced. The subject index is extensive, but, and this is probably the most serious fault with the book, it is not complete. Many substances are mentioned in several places in the text but only receive one reference in the index. Some substances are, unfortunately, mentioned in the text but not in the index.

These faults apart, the editors can congratulate themselves and the authors on producing a book which cannot help but be of great use to every cosmetic manufacturer (or would-be manufacturer) throughout the world.

Cyril W. Ridout

l'Énergie Nucléaire dans le Monde

Programmes et Développements Prévus. Par T. Reis. Pp. x+296. (Paris : Dunod, 1957.) 2,900 francs.

THIS book provides a useful summary of the world's energy consumption and its distribution among available sources. It provides statistics of the energy consumption of most of the countries of the world and summarizes the predictions that have been made about the future growth of energy requirements.

The second chapter describes the atomic energy organizations of more than forty countries, lists their reactors of different types and gives their nuclear power programmes—where they exist. The information given is as accurate as could be expected when programmes change rapidly.

The third chapter summarizes the conclusion about the world's future requirements and predicts that in Western Europe nuclear energy will be providing between 15 and 20 per cent of all electricity generated by 1975. This would still only be 18 per cent of the indigenous energy deficit of the Organization for European Economic Co-operation countries.

A final table classes eight countries in order of nuclear power output by 1960, 1965 and 1970/75. According to this, Britain will take third place in 1960 and second place in later years, Canada being credited with second place in 1960. These predictions are of little value in the present shifting phase of national programmes. J. D. COCKCROFT

Contributions to the Flora of Venezuela

By Julian A. Steyermark and Collaborators. (Fieldiana : Botany, Vol. 28, No. 4.) Pp. ii+512. (Chicago, Ill. : Chicago Natural History Museum, 1957.) 7.50 dollars.

THIS volume is the final instalment of new records, notes on range extensions, and descriptions of new species based on Dr. Steyermark's notable botanical collections on the mountains of Venezuela, especially on those of the Guayana Highlands, some of which had never before been explored by biologists. These contributions are of absorbing interest for the taxonomist and plant geographer, but the promise to include special notes on geology, topography, floral zones and ecological aspects in the sections devoted to certain mountains can scarcely be said to have been fulfilled. This final volume closes with a list, in taxonomic order, of all the new plants which have been described in the contributions. A complete set of Dr. Steyermark's specimens is placed in the Chicago Natural History Museum.

BBC Handbook, 1958

Pp. 288. (London : British Broadcasting Corporation, 1957.) 5*s*.

THE B.B.C. Handbook 1958 includes the balance sheet and accounts for the year ended March 31, 1957, as well as a brief analysis of income and expenditure for that year among the regions, an analysis of both sound and television programmes and a comparison of programme services costs. It also gives a comprehensive account of the Corporation's activities prior to the recent changes in the sound programmes. Following Sir Alexander Cadogan's foreword, a chapter on the constitution of the Corporation refers briefly to the 'fourteen-day rule' forbidding the anticipation of Parliamentary debates, but neither there nor elsewhere is there any discussion of live issues. The Handbook is essentially factual and descriptive : besides a review of the year's broadcasting, there are chapters on the domestic broadcasting services ; the external services ; the work and responsibilities of the engineering departments and their technical facilities and installations ; programme policy and practice ; and relations with the public, the latter including some advice on how to get the best reception. The texts of the Corporation's charter, licence and agreement and supplementary agreement are given, and the Handbook includes a useful select bibliography.

The Terpenes

By the late Sir John Simonsen and Dr. W. C. J. Ross. Vol. 4 : The Triterpenes and their Derivatives : Hydrocarbons, Alcohols, Hydroxy-aldehydes, Ketones and Hydroxy-ketones. Pp. ix+524. (Cambridge : At the University Press, 1957.) 70*s*. net.

THIS is the fourth volume of a series, so it needs little in the way of general introduction. It contains accounts of the structures, degradations and general reactions of the compounds listed in the title, and some indication of stereochemistry. References are given up to 1956, but there are indications that some sections were substantially completed rather earlier than this, which is a disadvantage, although perhaps an inevitable one in a rapidly moving field. The volume is otherwise a very clear and complete account of the subject. The one quarrel which the reviewer has with it is the inadequate consideration given to stereochemistry. The results are stated in most cases, it is true, but without much account of the way they are derived. Conformations are not given. This is clearly a matter of deliberate policy, but the result is rather like raspberry jam without the seeds, wholesome and nourishing but a trifle unreal. It is a definite drawback to the use of the single volume. However, nobody who has the earlier volumes or who is interested in research or teaching in this field can afford to be without this book.

A. J. BIRCH

Kandelman's Krim

A Realistic Fantasy. By Prof. J. L. Synge. Pp. 175. (London : Jonathan Cape, Ltd., 1957.) 15*s*. net.

AN Orc, a Kea, a Unicorn and a Plumber, meeting to discuss the nature of infinity and the attributes of God, are joined by a sky-blue Goddess ; her knowledge of arithmetic resembles Sam Weller's knowledge of London, but she does not understand why the debaters appear to be so interested in mathematics. Instruction is thrust upon her—integers, fractions, complex numbers, sequences, limits. Controversy is enlivened by flashes of wit and chunks of Carrollian nonsense.

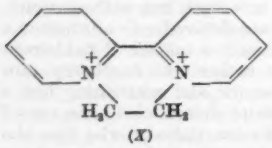
Temptation to see an allegory is strong. Surely the Plumber, with his strong constructive sense, his appreciation of mathematical techniques and his deprecation of formalism and academic subtlety, is the modern mathematical physicist, while the sceptical and pedantic Orc is the orthodox pure mathematician, roused only once or twice to a passion which suggests descent from the Orc of William Blake. But the allegory is obscure, and the long preface, with its discussion of meaningful and meaningless statements, its references to Berkeley and to the author's ancestor, Bishop Hugh Hamilton, may be a veiled warning against seeking a meaning where none exists. The fun is there to be enjoyed, and only the careless reader will miss the implication that real mathematics is as much the product of imagination as of logic. T. A. A. BROADBENT

A NEW HERBICIDE

1 : 1′-ETHYLENE-2 : 2′-DIPYRIDYLIUM DIBROMIDE

By R. C. BRIAN, R. F. HOMER and J. STUBBS
Imperial Chemical Industries, Ltd., Jealott's Hill Research Station, Bracknell, Berks
AND
R. L. JONES
Imperial Chemical Industries, Ltd., Pharmaceuticals Division, Alderley Park, Macclesfield, Cheshire

DURING the early spring of 1955, in the course of an investigation at Jealott's Hill Research Station into the herbicidal properties of a series of quaternary ammonium compounds, one chemical showed exceptional activity. This was originally prepared by R. J. Fielden at Blackley by the quaternization of 2 : 2′-dipyridyl with ethylene dibromide; a reaction which gives rise to a single well-defined crystalline product which has been shown to be 1 : 1′-ethylene-2 : 2′-dipyridylium dibromide (*X*)[1].



(*X*)

(*Y*)

Elementary analysis agrees with the empirical formula $C_{12}H_{12}N_2Br_2$, in which all the bromine is ionic, and hydrogenation over Raney nickel in the presence of sodium acetate gives a fully saturated base $C_{12}H_{22}N_2$(*Y*), b.p. 74–76°/0·2 mm., which has molecular weight (cryoscopic in benzene) 186. $C_{12}H_{22}N_2$ requires 194. This eliminates possible dimeric or polymeric structures.

1 : 1′-Ethylene-2 : 2′-dipyridylium dibromide forms a pale yellow monohydrate from water m.p. > 320° decomp. having in aqueous solution $\lambda_{max.}$ 308,311 mμ; ε ~ 18,000. The material is readily soluble to the extent of 70 gm. in 100 c.c. of water at 20° C. and is stable in acid or neutral solution. In alkaline solution coloured complex products are formed which appear to arise from the opening of one of the pyridine rings, a process associated with the uptake of one molecule of alkali.

In the greenhouse, aqueous solutions of *X* with added wetter (0·3 per cent 'Agral *LN*'), applied as foliage sprays at the rate of 100 gal./acre, gave complete kill of wheat, sugar beet, white mustard, marigold (*Calendula* sp.), red clover and cleavers (*Galium aparine*) at dosages down to ½ lb./acre. At ¼ lb./acre, there was 100 per cent kill of marigold, almost complete kill of mustard and serious damage to the remaining species. Even at ¼ lb./acre, *X* seriously damaged all the plants other than cleavers. In the absence of wetter, the chemical was almost equally effective, though it was less damaging to wheat and clover. Similar results were obtained with low-volume (20 gal./acre) applications. The action of the chemical was very rapid.

From general observations on the effects of the treatment, and because the volume of application had so little effect on the activity, it seemed likely that *X* was acting systemically. Proof of the uptake and translocation through the aerial parts of broad bean and oat was readily obtained. Further, it was found that entry through intact bean leaves was very rapid, taking place within five minutes of application. Root uptake by oats growing in culture solution also occurred, though soil drenches had no effect on pot-grown plants. This apparent anomaly was explained when it was found that *X* was rapidly and completely adsorbed by soil.

Subsequent greenhouse tests showed that *X* was highly active against several common weeds at ¼–½ lb./acre, including the species resistant to 2,4-D and MCPA, chickweed (*Stellaria media*), groundsel (*Senecio vulgaris*), mayweed (*Matricaria* spp.) and speedwell (*Veronica* spp.). Russian thistle (*Salsola pestifer*), a common arable weed of North America, was highly susceptible, being killed at rates as low as ¼ lb./acre.

Because of its high activity in these initial tests, *X* was clearly worthy of further evaluation as a herbicide. Preliminary field trials confirmed that there was generally little difference between high-volume and low-volume application. For this reason, in most of the later trials the treatments were applied at 20 gal./acre.

Excellent potato haulm destruction was given by *X* at 1–2 lb./acre in a series of fourteen trials carried out in the period 1955–57, haulm kill being equal to that given by the standard sulphuric acid and sodium arsenite treatments and faster than the latter. Kill of common annual weeds, including fat hen (*Chenopodium album*), red shank (*Polygonum persicaria*), annual nettle (*Urtica urens*), chickweed (*Stellaria media*) and black nightshade (*Solanum nigrum*) by the new chemical at these rates was usually superior to that given by either sulphuric acid or sodium arsenite. Rain falling shortly after application had no effect on the herbicidal activity of *X* although it reduced that of the arsenite. The storage properties of the potato tubers were unaffected by the *X* treatments.

Indications that *X* was of value as a pre-harvest desiccant of red clover seed crops were obtained in a preliminary trial in 1956. This finding was confirmed in a more detailed trial later in that season and again in 1957, when it was shown that low-volume application of *X* at 1–2 lb./acre desiccated the crop at

least as well as sulphuric acid (15 per cent B.O.V.) applied at 100 gal./acre.

Damage to cereals by *X* in the field was less than had been anticipated from the greenhouse observations. Oats proved to be the most resistant, and rates of up to 2 lb./acre mainly caused only localized foliar scorch. Wheat, maize and barley showed increasing damage in that order. Temporary chlorosis of the younger leaves sometimes developed, particularly with the more susceptible species. Grain yields in weed-free stands of spring oats and wheat in 1956 were not reduced following spray application at the 2–3 leaf stage of up to 1 lb./acre, but were affected by later treatments. Yields of spring barley were reduced in all cases; maize was not taken through to yield. In a series on weed-infested crops in the same season the treatments had no effect on yield in one trial on winter wheat and two on winter oats. Significant yield reductions, however, were recorded at two other centres where spring wheat and oats had been sprayed at later stages of development at 40 and 100 gal./acre, respectively.

Most species of broad-leaved annual weeds present in these cereal trials were adequately controlled by *X* at 1 lb./acre, exceptions being corn poppy (*Papaver rhoeas*), corn marigold (*Chrysanthemum segetum*) and parsley piert (*Aphanes arvensis*), which were markedly resistant. The activity shown by *X* in greenhouse tests against cleavers, chickweed, groundsel, mustard and speedwell was confirmed in these field trials. In addition, knotgrass (*Polygonum aviculare*), black bindweed (*P. convolvulus*), redshank (*P. persicaria*), charlock (*Sinapis arvensis*), runch (*Raphanus raphanistrum*), cut-leaved dead nettle (*Lamium hybridum*), many-seeded goosefoot (*Chenopodium polyspermum*), fat hen (*C. album*), orache (*Atriplex* spp.) and scarlet pimpernel (*Anagallis arvensis*), all proved to be susceptible at rates of 1 lb./acre or less.

In these, and other trials, *X* gave good kill of top growth of several broadleaved perennial species, including dock (*Rumex* spp.), creeping thistle (*Cirsium arvense*), mint (*Mentha* spp.), field bindweed (*Convolvulus arvensis*), ox-tongue picris (*Picris hieracioides*) and ground elder (*Aegopodium podagraria*). Basal regeneration in these perennials, however, quickly nullified the effect of the treatment. Similar responses were given by a range of grass species.

Low-volume applications of *X* at 2–5 lb./acre gave good top kill of various brushwood species, including bramble (*Rubus* spp.), briar (*Rosa* spp.), hawthorn (*Crataegus monogyna*), elder (*Sambucus nigra*), elm (*Ulmus* spp.). In all cases, however, the initial dieback was followed by basal regeneration.

Clearly, 1 : 1′-ethylene-2 : 2′-dipyridylium dibromide is a very potent, translocatable, rapid-acting, non-persistent, post-emergence herbicide. Potential outlets seem to lie mainly in the field of potato haulm destruction, crop desiccation and non-selective weed-killing, though it may find some application as a selective weedkiller in cereals. More research is needed before the full potential of this new herbicide can be defined.

Considerable assistance with the field trials reported here was given by H. C. McIlvenny and L. G. Spencer.

[1] Imperial Chemical Industries, Ltd. (Fielden, R. J., Homer, R. F., and Jones, R. L.), British Patent Specification No. 785,732.

NON-CONSERVATION OF PARITY

THE situation in the field of elementary-particle decay interactions altered profoundly during 1957. With experiments demonstrating violation of parity in β-decay[1] and π–μ–*e*-decay[2] early in the year a new phase began in experimental work as well as in theoretical understanding of these weak interactions. A symposium, organized by Prof. R. E. Peierls, was held at the Royal Society on December 5 to assess the present situation in the field. The meeting was organized in two formal and one discussion session. An introductory talk by Prof. Peierls was followed by one from Dr. D. L. Pursey (Edinburgh), who gave a summary of β-decay and μ-decay theory. Dr. M. A. Grace (Oxford) surveyed the experimental situation in β-decay, and Prof. J. Cassels the situation in π–μ–*e*-decay. Drs. P. E. Cavanagh and E. C. Ridley described experimental techniques for measuring electron polarization and electron–neutrino correlation, and Prof. A. Salam (Royal College of Science, London) spoke on 'strange' particle decays. This article offers a brief discussion of some of the material presented.

The principle of space-reflexion symmetry asserts that there is no fundamental difference between right and left; that the results of any experiment look the same to an observer viewing the experiment directly as to one looking at its reflexion in a mirror. In elementary-particle physics this implies that transition probabilities for any reaction must not involve any pseudoscalar quantity. Pseudoscalar quantities are those which change sign on reflexion ($\mathbf{r} \rightarrow -\mathbf{r}$). Simple examples of these are products such as $\mathbf{p}_1 \wedge \mathbf{p}_2 \cdot \mathbf{p}_3$, where $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$ are three (momentum) vectors, or $\mathbf{J}.\mathbf{p}$, where $\mathbf{J}$ is an angular-momentum vector. (It may be recalled that angular momenta behave similarly to $\mathbf{r} \wedge \mathbf{p}$ for reflexions. For $\mathbf{r} \rightarrow -\mathbf{r}$, $\mathbf{p} \rightarrow -\mathbf{p}$, $\mathbf{J} \rightarrow \mathbf{J}$ and thus both $\mathbf{p}_1 \wedge \mathbf{p}_2 \cdot \mathbf{p}_3$ and $\mathbf{J} \cdot \mathbf{p}$ change sign.)

The principle of space-reflexion symmetry is known to hold in classical physics as well as in atomic and nuclear physics to all measurable accuracy. Yang and Lee[3] were the first to point out, in the summer of 1956, that no experimental confirmation had been obtained whether pseudoscalar quantities do in fact occur in expressions for transition-rates of decay processes. The first experiments performed with polarized neutrons[1] and μ-mesons[2] showed unmistakably that these rates are proportional to $a + b \langle \mathbf{J} \rangle \cdot \mathbf{p}_e$, where $\langle \mathbf{J} \rangle$ is the vector representing neutron or μ-meson spin and $\mathbf{p}_e$ is the momentum of the electron emitted. These experiments also showed one other characteristic which has proved extremely valuable for their theoretical interpretation. This was the observation that in all neutron (n) decays the emitted electrons spin in the opposite sense to their direction of motion[4] (left-polarization) with a polarization of magnitude v/c, while in the inverse transitions and in μ^+-decay[5] the emitted positron possesses right-polarization of the same magnitude.

All decays can be classified into two categories:

Category (1). Decays involving neutrinos (ν) as one of the decay products: (1) $\mu^{\pm} \rightarrow e^{\pm} + 2\nu$; (2) $n \rightarrow p + e^{-} + \nu$; (3) $\pi^{\pm} \rightarrow \mu^{\pm} + \nu$; (4) (*a*) $K^{\pm} \rightarrow \mu^{\pm} + \nu$; (*b*) $K^{\pm} \rightarrow \mu^{\pm} + \nu + \pi^{0}$; (*c*) $K^{\pm} \rightarrow e^{\pm} + \nu + \pi^{0}$.

Category (2). Decays not involving neutrinos: (5) $\Lambda \rightarrow p + \pi^{-}$; (6) (*a*) $\Sigma^{+} \rightarrow p + \pi^{0}$; (*b*) $\Sigma^{+} \rightarrow n + \pi^{+}$; (7) $\Sigma^{-} \rightarrow n + \pi^{-}$; (8) (*a*) $K^{\pm} \rightarrow \pi^{\pm} + \pi^{0}$ (θ-mode); (*b*) $K^{\pm} \rightarrow \pi^{\pm} + \pi^{\pm} + \pi^{\pm}$ (τ-mode).

The decays in the second category involve 'strange' particles only and violate 'strange-ness' conservation. Thus these present the deeper problem.

Before considering experimental results, we wish to make some theoretical remarks regarding decays in c tegory 1. From experience, one has learnt that the simplest procedure in neutrino theory is to consider only Majorana neutrinos (ψ). A Dirac (4-component) neutrino, ψ_D, is simply two Majorana neutrinos, ψ_1 and ψ_2, with a definite phase-relation between them ($\psi_D = \psi_1 + i\psi_2$). There are two independent basic assumptions which have been made in all present theoretical thinking, namely, (1) that the neutrino mass and self-mass are identically zero; and (2) that there is a conservation law for light particles (μ-mesons, electrons and neutrinos). In any process the total number of light particles minus anti-particles remains unaltered.

Specializing to the case of single Majorana neutrino, these two assumptions lead to the so-called 2-state theory[4]. In this theory: (*a*) Both parity as well as charge-conjugation invariance must be violated. (*b*) Neutrinos are polarized, either along (ν_R), or opposite (ν_L) to their direction of motion. ν_L may be considered as the anti-particle of ν_R ($\nu_L = \nu_R$). (*c*) The electron (or positron) accompanying ν_R is right-polarized (with polarization of magnitude v/c) if the interaction is of 'vector' (V) or 'axial-vector' (A) type; it is left-polarized if the interaction is of 'scalar' (S), 'tensor' (T) or 'pseudoscalar' (P) type.

One may consider two completely independent Majorana neutrinos, ψ_1 and ψ_2, or a Dirac neutrino, $\psi_D = \psi_1 + i\psi_2$, obtaining further generalizations of the theory. In the latter case the distinction between a neutrino and anti-neutrino does not depend on the state of polarization of these particles (ν_L and ν_R are both right-polarized but not identical).

Consider briefly the experimental data for processes in category 1 and their theoretical interpretation:

(1) $\mu \rightarrow e + 2\nu$.

(*a*) Experiments with electrons emitted by polarized μ-mesons show a backward–forward asymmetry, demonstrating parity non-conservation[2].

(*b*) The most accurate determination[7] of the Michel parameter, ρ, in the μ-decay spectrum gives a value of $0{\cdot}68 \pm 0{\cdot}02$. The 2-state theory predicts a value of $0{\cdot}75$ provided that, in μ-decay: $\mu^{\pm} \rightarrow e^{\pm} + \nu_L + \nu_R$.

(*c*) In the 2-state theory, writing the decay interaction in the form $g_V H_V + g_A H_A$, where V and A refer to vector and axial-vector couplings, $\{H_V = \overline{(\mu^{+} V e^{+})}\ (\nu_R V \nu_L)$, etc.$\}$, the asymmetry parameter mentioned in (*a*) corresponds to equal V and A ($|g_V| = |g_A|$). The measurement of positron polarization and the result that these are right-polarized gives $g_V = -g_A$.

(*d*) The μ-mesons in these experiments were produced from π-decays at rest, and (in accordance with the expectation from 2-state theory) were nearly 100 per cent polarized. From the experimental observation that positrons from these μ^{+}-decays are emitted predominantly in the direction opposite to the μ^{+}-direction of motion[5], one may infer that μ^{+}-mesons from π^{+}-decay are also right-polarized.

(*e*) Assuming light-particle conservation, from $\mu^{+} \rightarrow e^{+} + \nu_L + \nu_R$, and $\pi^{+} \rightarrow \mu^{+}{}_R + \nu_R$ (necessarily so from the conservation of angular momentum) one would infer that μ^{+}, e^{+}, ν_L form the set of 'particles' and μ^{-}, e^{-}, ν_R the set of 'anti-particles'.

It is to be noted at this stage that the 2-state theory gives no explanation of why $g_A = -g_V$.

(2) β-Decay:

As mentioned before, experiments with polarized nuclei demonstrate unmistakably that parity is not conserved. The fact that electrons and positrons emitted in β-decay possess a high degree of longitudinal polarization provides a new tool for the determination of the fundamental β-interaction. If the 2-state theory with lepton conservation is assumed, the experimental result that positrons are right-polarized implies that positrons are always emitted together with ν_R-neutrinos. This would mean that the β-interaction is A and V.

The experimental situation on this question is in confusion. First, most experiments seem to agree on the interaction being S or V plus A or T. This follows from the absence of Fierz-interference terms (plus the assumption of time-reversal invariance). The detailed distinction between S or V and T or A is made by electron–neutrino correlation experiments which have nothing to do with violation of parity as such. Experiments with argon-35 seem to show V, experiments with helium-6 show T; neon-19 and neutron data are compatible with either (S,T) or (V,A) combinations. It would appear that if the helium-6 experiments[8] stay firm, the 2-state theory with lepton conservation will have to be abandoned, notwithstanding its successes.

Turning to a consideration of decays in category 2, data have recently become available which demonstrate violation of parity in these processes also. The most conclusive evidence comes from $\Lambda \rightarrow p + \pi^{-}$. For a sample of polarized Λ-particles at rest, with spin pointing along $\langle \mathbf{J} \rangle$, it is sufficient to show that the decay probability, W, depends on $\langle \mathbf{J} \rangle \cdot \hat{\mathbf{p}}_{out}$ ($\hat{\mathbf{p}}_{out}$ is the direction of π-momentum). It transpires, providentially, that in the production reaction $\pi^{-} + p \rightarrow \Lambda + K$, the Λ-particles produced by π-mesons of about 1-BeV. energy possess a high degree of polarization. Since, quite generally,

$$\langle \mathbf{J} \rangle \propto \mathbf{p}_{in} \wedge \mathbf{p}_{\Lambda}$$

where $\mathbf{p}_{in}$ is incident π^{-}-momentum and $\mathbf{p}_{\Lambda}$ the Λ-momentum in the centre-mass frame, it is sufficient to look for an asymmetry in the number of decay π's in a direction normal to the Λ-production plane and in the opposite direction. Writing

$$W = 1 + \alpha \langle \mathbf{J} \rangle \cdot \hat{\mathbf{p}}_{out}$$

the combined results of the Columbia, Bologna, Pisa, Michigan, Brookhaven and Berkeley groups give $\alpha \overline{\langle \mathbf{J}_{\Lambda} \rangle} = 0{\cdot}52 \pm 0{\cdot}10$. Here $\overline{\langle \mathbf{J}_{\Lambda} \rangle}$ is an average taken over a number of production angles. From angular distribution data in Λ-production it has been estimated that $\overline{\langle \mathbf{J}_{\Lambda} \rangle} \leq 0.68 \pm 0{\cdot}03$, so that the fundamental asymmetry parameter[9], $\alpha \geqslant 0{\cdot}77 \pm 0{\cdot}15$. The corresponding results for Σ^{+} and Σ^{-} particles give

$$\alpha \overline{\langle \mathbf{J} \rangle}_{\theta+} = -0{\cdot}36 \pm 0{\cdot}20$$

$$\alpha \overline{\langle \mathbf{J} \rangle}_{\tau'} = -0{\cdot}13 \pm 0{\cdot}26$$

The two decay modes of $K+$-meson (θ-mode, $\pi+ + \pi^0$, and τ-mode, $\pi+ + \pi+ + \pi^0$) provide additional evidence for violation of parity. The final state consisting of $\pi+ + \pi^0$ mesons has spin-parity assignments $0+$, $1-$, $2+$, etc. It is easy to show that corresponding assignments for the $(\pi+ + \pi+ + \pi-)$ state are $0-$, $1+$, $1-$, $2+$, etc. There is considerable evidence that the spin of the K-meson is zero. Thus, K-particles decay through two modes, with opposite intrinsic space-reflexion properties.

For the theoretical interpretation of 'strange'-particle decays there is nothing analogous to the neutrino to carry the blame for violation of parity. It may be recalled that it was the possibility of making the gauge transformation $\psi_\nu \rightarrow \gamma_5\psi_\nu$ for the neutrino (on account of its zero-mass) which led to the 2-state theory. One would like to have something analogous to this transformation for 'strange'-particles.

Already in neutrino physics there are indications that the transformation, $\psi_\nu \rightarrow \gamma_5\psi_\nu$, is not enough. There is the obstinate fact in μ-decay that $g_A = -g_V$. One can perhaps find a natural explanation for this by generalizing the neutrino gauge to electrons or μ-mesons, in the following manner. We postulate that all μ-interactions or electron-interactions are invariant for the transformations

$$\psi_e \rightarrow \gamma_5\psi_e, \quad m_e \rightarrow -m_e$$

$$\text{or } \psi_\mu \rightarrow \gamma_5\psi_\mu, \quad m_\mu \rightarrow -m_\mu$$

In so far as the electro-magnetic interaction is not changed by these (mass-reversal) transformations, invariance for mass-reversal appears as a universal law for all light particles.

Unfortunately, the current theories of strong interactions are not mass-reversal invariant. J. Sakurai[10] has, however, proposed that as a start towards obtaining the interaction for 'strange'-particle decays one may postulate that all 'strange'-particle decays arise from weak couplings of the type $(\overline{\Lambda}\, N)\ (\overline{N}\, N)$, where N stands for nucleons, and that mass-reversal applies to these. One then obtains the result that there exists a universal 4-field interaction between Fermi fields with equal mixtures of A and V. In the particular case of Λ-decay, this gives $\alpha = 0{\cdot}89$. This unified point of view appears attractive although it suffers from a number of theoretical objections. The chief experimental evidence against it, however, is the result of $e - \nu$ correlation experiments on helium-6 decay, mentioned before.

This discussion would not be complete without some mention of the so-called PCT theorem[11]. It can be shown that invariance of a theory for Lorentz rotations automatically implies its invariance under each of the six products PCT, TPC, PTC, etc., where P stands for parity, C for charge-conjugation and T for time-reflexion invariance. It is clear that —besides parity—at least one other invariance must be violated in weak decays. It can be shown that all experiments imply C-violation. Weak interactions are not charge-conjugation symmetric. It is still an open question whether or not time-reflexion symmetry holds in these processes. A. Salam

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VACANCIES AND OTHER POINT DEFECTS IN METALS AND ALLOYS

IN recent years there has been considerable interest in the behaviour of lattice vacancies, interstitial atoms and other more complex point defects in metals. In order to survey this subject, the Metal Physics Committee of the Institute of Metals invited six papers which would form the basis of a symposium. By kind permission of Sir John Cockcroft, the symposium was held at the Atomic Energy Research Establishment, Harwell. On December 9, following visits to the reactors DIDO and PLUTO and some laboratories, an introductory lecture was given by Prof. R. W. K. Honeycombe (University of Sheffield). He showed that a knowledge of the characteristics of point defects is necessary for the understanding of a wide range of metallurgical phenomena, including quench- and irradiation-hardening, fatigue and creep.

On December 10 the six invited papers were briefly presented to an audience of about three hundred, and general discussion followed. Dr. A. H. Cottrell (Atomic Energy Research Establishment, Harwell) considered how point defects can cause or contribute to hardening and softening processes in metals at temperatures lower than those at which conventional high-temperature creep occurs. The most spectacular hardening is that produced by quenching very pure metals from temperatures near the melting point. If the quench is sufficiently rapid, the high-temperature equilibrium concentration of vacancies remains randomly dispersed, and there is little or no hardening. Then if the metal is warmed sufficiently for the vacancies to agglomerate or migrate to dislocations, considerable hardening can occur. The detailed interpretation of quenching experiments was repeatedly shown to be of crucial importance for the understanding of the behaviour of lattice vacancies. When a metal is bombarded by energetic particles, occasional collisions lead to the knocking of atoms from lattice sites and the consequent production of equal numbers of vacancies and interstitials. The

hardening produced by irradiation is often considerable, but the processes are apparently complex. It appears that both the initiation of plastic deformation and its continuation are usually made more difficult, indicating that point defects do interact with dislocations to give 'source hardening', and with each other to give general lattice hardening. During plastic deformation of annealed metals, lattice vacancies are produced and in certain circumstances can lead to readily observed increases in local diffusion rates. This is particularly prominent in fatigue, and it is probable that there is also a characteristic fatigue-hardening produced by point defects which more resembles quench- and irradiation-hardening than work-hardening.

The effects of point defects on some physical properties afford means for the study of their generation, movement and disappearance. The existing theoretical and experimental evidence was summarized by Dr. T. Broom and R. K. Ham (University of Birmingham). It was concluded that while the measurement of electrical resistivity is often experimentally simple, the uncertainties in interpretation are often such as to render more desirable the rather difficult measurement of stored-energy. The other properties considered were density, thermo-electric power, magnetic behaviour, thermal conductivity and nuclear magnetic resonance. The most useful experiments are obviously those in which the changes of many properties are studied simultaneously.

Dr. W. M. Lomer (Atomic Energy Research Establishment, Harwell) considered the transport of atoms through metallic lattices in various types of diffusion processes, of which vacancy diffusion is the most important. In many face-centred-cubic metals the details are well understood, but in other lattices the 'structure' of a vacancy and of other point defects remains uncertain and hinders agreement between theory and experiment. Vacancies in alloys usually associate preferentially with one species of atom, and useful information can be gained about this indirectly from quenching experiments and directly from tracer diffusion measurements in homogeneous alloys. It is probable that non-equilibrium concentrations of vacancies introduced into homogeneous alloys, for example, by irradiation, can only lead to accelerated diffusion over very small distances because of the density of vacancy traps. Chemical diffusion in inhomogeneous systems is more complex on account of the complication of the gradient of chemical potential. Briefly, each species of atom will migrate at a different rate along the gradient leading to shifting of diffusion interfaces, to 'vacancy pumping' and frequently to formation of porosity due to local vacancy supersaturations. The detailed behaviour of sinks (and sources) for vacancies is important not only in such systems but also in vacancy-creep and in sintering.

The activation energy for creep at high temperatures has frequently been found to be very close to that required for self-diffusion. In a general account of high-temperature mechanical properties, Dr. D. McLean (National Physical Laboratory) showed how this is accounted for by mechanisms involving climb of dislocations caused by their absorption of thermal vacancies. The relative rates of creep in various metals can be qualitatively explained by considering the structure of the dislocations involved and whether they can readily act as sinks for vacancies. Alloying usually reduces the rate of secondary creep, and it is possible by simple calculations to indicate what modifications to the dislocation climb model may occur in particular cases. During the later stages of creep tests, voids frequently appear at grain-boundaries. The hypothesis that these are formed by the condensation of vacancies is confirmed after critical examination of the conditions for nucleation and growth.

Dr. P. L. Pratt (University of Birmingham) contributed a paper discussing the role of point defects in determining the mechanical properties of ionic crystals. Historically, there is good precedent for such studies casting light on similar properties in metals, and it was shown that quench-hardening, generation of vacancies by moving dislocations, dislocation-pinning and vacancy cluster hardening all occur in crystals of sodium chloride. However, an important contribution to hardening in ionic crystals arises from the positive charge carried by dislocations which itself is a consequence of differing energies of formation of positive and negative ion vacancies. The line charges are screened by clouds of oppositely charged vacancies and this causes additional dislocation-pinning.

The last paper of the symposium, by E. C. Williams and P. C. S. Hayfield (Imperial Chemical Industries, Metals Division, Birmingham), dealt with the character of the metallic surface conceived of as containing an abnormal concentration of point defects and the influence that this has upon dry corrosion. Many new experimental results were presented from work in progress, and it was considered that they could best be explained by introducing into the theory of oxidation the concept of the trapping of electrons by localized structural defects.

In opening the general discussion, Prof. R. Maddin (University of Pennsylvania) gave new results for the hardening of polycrystalline copper by quenching. Specimens which had been rapidly quenched to room temperature could be hardened by slight warming, but heating at a higher temperature caused softening. Both processes occurred with an activation energy of 0·7 eV. and were believed to be associated with the movement of single vacancies. In a new theoretical interpretation of the effects of quenching on the electrical resistivity of gold it was proposed that quenching from low temperatures ($\sim 500°$ C.) produced single vacancies but that during quenching from high temperatures ($\sim 900°$ C.) some pairs, clusters and collapsed clusters (sessile dislocations) were created and then later modified appreciably the kinetics of annealing-out of the extra resistivity. Other experimental results were presented on the effect of straining and rate of strain on self-diffusion in silver single crystals. At appreciable rates of strain the activation energy for diffusion fell to $\sim 0{\cdot}7$ eV., indicating this value as that required for the diffusion of vacancies produced by straining. Dr. M. C. Inman (National Physical Laboratory) gave some results for the effects of straining on the diffusion of antimony in copper and Dr. B. S. Berry (Fulmer Research Institute) for the energies for diffusion in quenched aluminium 4 per cent copper alloy.

Quenching of aluminium was discussed by M. M. Wintenberger (Vitry, France) both with reference to hardening and effects on electrical resistivity. Evidence was given which showed that annealing after a rapid quench gave a large residual resistivity and, because slight deformation reduced this, it was likely that it could be attributed to clustering of vacancies. The importance of clustering of vacancies in the

hardening and subsequent softening of quenched sodium chloride crystals was emphasized by Dr. B. H. Kear (Tube Investments Research Laboratories). Describing work done at the University of Birmingham, he showed the effects of various quenching media, specimen sizes and quenching temperatures. After eliminating effects due to quenching strains there remained features closely analogous to those produced by single vacancies and vacancy clusters in metals.

Dr. T. H. Blewitt (Oak Ridge, temporarily at Harwell) referred to recent results in his own laboratory. Tensile tests on copper single crystals had been carried out at 20° K. in a nuclear reactor after maintaining the specimens at that temperature throughout a bombardment of 4×10^{17} neutrons. The hardening produced remained unchanged by pulse anneals up to about 250° K. despite the large drop of extra resistivity at ~ 35° K. and its subsequent slow fall. Some slight decrease in critical shear stress occurred at ~ 250° K. but complete annealing did not occur until higher temperatures. New measurements of the energy associated with the 35° K. resistivity-annealing process yielded 0·3 cal./mole for a bombardment of 4×10^{17} neutrons. Dr. Blewitt suggested that these results, taken in conjunction with his own previously published work on the effects of alloying on the 35° K. process in copper, precluded any simple interpretation of hardening as due to dispersed single vacancies and interstitial atoms. The annealing kinetics at 35° K. were apparently first order with a range of activation energies, and might provisionally be ascribed to the migration of crowdions.

The mechanisms of irradiation-hardening of copper after neutron bombardment were discussed by Dr. M. J. Makin (Harwell). His experiments on single crystals and polycrystalline copper showed that there is a large and temperature-dependent increase in the stress required to generate dislocation loops; this must originate from the interaction of one or more of the products of bombardment (vacancies, interstitials, etc.) with dislocations. In addition, there is a general lattice hardening (independent of temperature) which makes it difficult to maintain the movement of dislocations; this could be attributed to the clustering of point defects or to the formation of sessile dislocations. Some preliminary results were given for the effects of electron irradiations on the strength of copper single crystals. Evidence for the dual nature of irradiation-hardening was also given by Dr. A. T. Churchman (A.E.I. Research Laboratories, Aldermaston) in an analysis of the dependence of neutron-bombardment hardening of mild steel upon grain size and temperature, and by Dr. A. D. Whapham (Atomic Energy Research Establishment, Harwell), who showed photomicrographs illustrating the propagation of slip in lithium fluoride crystals hardened by electron bombardment. Dr. R. E. Smallman (Atomic Energy Research Establishment, Harwell) gave results showing how X-ray measurements indicate that a change occurs in the neutron bombardment of lithium fluoride at a critical dose of about 10^{17} nvt. Below this dose the lattice parameter increases with dose, but it remains constant above it; below, there are no diffraction streaks from single crystals and there is no line broadening and little low-angle scattering, but above 10^{17} nvt all these increase. Again, this may indicate condensation of point defects at high doses.

Various considerations suggest that such alternating strain as occurs during fatigue tests may be a prolific source of vacancies. R. K. Ham (University of Birmingham) presented new results which showed that the fatigue hardening of copper single crystals at room temperature is somewhat analogous to that produced by irradiation. Plastic flow in a tensile test following a fatigue treatment starts in the fatigue striae, and then at a stress some 30 per cent higher than the fatigue stress (and typically about 50 times higher than the critical stress of the virgin crystal) there is a small yield drop and a Lüders band passes through the crystal. The temperature-dependence of this fatigue hardening is high. Less-detailed results obtained for zinc crystals were described by Dr. G. B. Greenough (U.K. Atomic Energy Authority, Windscale). Dr. H. M. Rosenberg (University of Oxford) considered that electrical resistivity changes during fatigue of copper suggest that many more defects are created than during unidirectional deformation. The production of vacancies by unidirectional deformation is believed to be responsible for discontinuous flow in strain-ageing alloys: previous work has been done on dilute alloys, but S. G. Harris (University of Birmingham) showed how the Portevin–Le Chatelier effect in concentrated commercial and high-purity binary aluminium alloys is modified by a strain-induced precipitation process. This in turn can result in strikingly unusual 'shear' fractures after considerable plastic extension.

Recent experiments on copper bombarded with α-particles were described by Dr. R. S. Barnes (Atomic Energy Research Establishment, Harwell). On subsequent heating, bubbles of helium only appear where there is a prolific source of vacancies. The major sources of vacancies thus revealed are free surfaces and grain boundaries, with apparently only occasional dislocations. Dr. J. Nutting (University of Cambridge) suggested that, in technical creep-resisting alloys, vacancies could be produced as a result of the volume changes involved in the dissolution of small precipitates or their change in composition.

The analysis of new results for the creep of copper between 400 and 750° C. was discussed by Dr. P. Feltham (University of Leeds). Below a critical stress the rate of creep is controlled by the climb of edge dislocations, occasioned by the condensation of vacancies at jogs, and the activation energy is about 1·4 eV.; above the critical stress (identified as the strength of Cottrell–Lomer barriers) creep is controlled by the movement of screw dislocations containing jogs and the activation energy is about 2·2 eV.

Dr. A. B. Lidiard (University of Reading) contributed a discussion of diffusion in ordered alloys, and Dr. R. W. Cahn (University of Birmingham) indicated how in such alloys creep phenomena depend markedly upon the degree of order near the critical temperature.

Some criticism of the theory of Williams and Hayfield was offered by Dr. T. P. Hoar (University of Cambridge), who thought that their derivation of logarithmic oxidation rates could depend on other rate-controlling processes. New evidence for the effects of point defects on physical properties was given by Dr. H. M. Rosenberg (heat conductivity in strained α-brass single crystals) and by Dr. E. O. Hall (University of Sheffield) concerning effects of neutron-bombardment on the magnetic behaviour of single crystals of 2 per cent silicon ferrite. Fairly detailed analysis of the magnetic results was possible, and interpretations were offered in terms of an increase in density of dislocations and jogs and the creation of aggregates of point defects.

T. Broom

INTERNATIONAL COMMISSION ON ENZYMES

At the second general assembly of the International Union of Biochemistry, held in Brussels in August 1955, it was agreed to establish an International Commission to consider those problems of enzymology in which international co-operation would be useful, and especially to make recommendations for a more logical and a more generally satisfactory system for the nomenclature and classification of enzymes.

In the following year, Prof. M. Florkin, the president of the International Union of Biochemistry, called an *ad hoc* committee together in Paris. At this meeting it was finally agreed that the terms of reference of this Commission should in the first instance be: "To consider the classification and nomenclature of enzymes and co-enzymes, their units of activity and standard methods of assay, together with the symbols used in the description of enzyme kinetics". It was further agreed that the Commission should consist of ten ordinary members and two corresponding members. Dr. Malcolm Dixon was appointed president of the Commission and Prof. O. Hoffmann-Ostenhof secretary. Prof. E. Cherbuliez was present at this meeting as a representative of the Section of Biological Chemistry of the International Union of Pure and Applied Chemistry.

As a result of this meeting the following people agreed to serve on the Commission: *Ordinary members:* A. E. Braunstein (U.S.S.R.), S. P. Colowick (United States), P. A. E. Desnuelle (France), M. Dixon, president (United Kingdom), W. A. Engelhardt (U.S.S.R.), E. F. Gale (United Kingdom), O. Hoffmann-Ostenhof, secretary (Austria), A. L. Lehninger (United States), K. Linderstrøm-Lang (Denmark), F. Lynen (Germany); *Corresponding members:* F. Egami (Japan), L. F. Leloir (Argentine).

The work of the Commission was begun shortly after the appointment of members was completed, and a number of documents dealing with various different topics were circulated by the president and secretary for the consideration of the members.

The next meeting of the Commission took place in Paris in July 1957. One of the first pieces of business to be taken up at this meeting was a proposal by Dr. Gale that a philologist should be invited to participate in the work of the Commission. This somewhat novel and highly acceptable proposal was welcomed by the Commission, and Mr. H. S. Davies, Fellow of St. John's College, Cambridge, has now agreed to serve as a corresponding member. Although the work of the Commission is still in its early stages, a number of important decisions have been reached, and it is possible already to see the shape of the final recommendations. For example, it was agreed that a dual system of nomenclature should exist in enzymology, in which each enzyme should be given an exact systematic name, which in most cases will be a new name coined by the Commission, and also a short, trivial name, using for this, whenever possible, the present-day name. The systematic name for a given enzyme should as far as possible be descriptive of the reaction catalysed by the enzyme; thus, in the case of transferring enzymes the systematic name would be in accordance with the scheme 'donor–acceptor–group transferred–transferase', for example, alanine-α-ketoglutarate-amino-transferase, although 'transaminase' might well remain as a permissible trivial name. Enzymes catalysing oxido-reductions would be named oxidoreductases in the systematic nomenclature, according to the scheme 'donor-acceptor oxidoreductase', although again for everyday use it would probably be recommended that the terms 'dehydrogenase' and 'reductase' should be retained. A special sub-commission was set up to consider the nomenclature of cytochromes.

A preliminary discussion also took place on the question of the units of enzyme action and on the kinetic symbols to be used in the description of enzyme-catalysed reactions.

A joint meeting of the Commission on Enzymes with the Commission on Biochemical Nomenclature of the International Union of Pure and Applied Chemistry was also held in July, at which the nomenclature of 'pyridine nucleotides' was raised. It was agreed that the International Union of Pure and Applied Chemistry Commission should be asked to bring forward recommendations as to the naming of these compounds, so that the Commission on Enzymes would be provided with an internationally agreed terminology for this group of co-enzymes, and would therefore be in a position to deal with the nomenclature of enzymes functioning with these co-factors.

It would be misleading at this early stage in the work of the Commission to attempt to set down in any detail the recommendations that have been put forward. Much more work remains to be done, and in suggesting new proposals relating to nomenclature and classification of any group of compounds it is clearly necessary to view the field as a whole. One important practical point that faces any nomenclature Commission has already been discussed, namely, the means of bringing into general use the newly proposed names. Here it will, at some stage, be necessary to seek the help of the major biochemical journals in different countries, and it is to be hoped that the final recommendations of this Commission will be given the widest publicity in order to facilitate their adoption by working biochemists and so minimize the existing confusing and reduplication of names that exist in this field.

The Commission will welcome suggestions from non-members and from outside bodies on all aspects of the field. These should be sent to the president or to the secretary of the Commission, but it is hoped that they would not be published before being considered by the Commission.

O. Hoffmann-Ostenhof
R. H. S. Thompson

OBITUARIES

Mr. D. L. Chapman, F.R.S.

DAVID LEONARD CHAPMAN, who died on January 17 at the age of eighty-eight, was little known personally outside the Universities of Manchester and Oxford, but the scientific work he quietly pursued for so many years was of the highest quality.

From Manchester Grammar School he went as an Open Exhibitioner to Christ Church, Oxford, and graduated with first-class honours in natural science in 1893. After teaching for a period at Giggleswick, he was appointed lecturer and demonstrator in chemistry under Prof. H. B. Dixon at the University of Manchester. In 1907 he was elected a Fellow of Jesus College, Oxford, to take charge of a new laboratory built by the College, which, because of the inadequacy of University laboratory accommodation, played a full part in the general teaching of chemistry in the University. The College laboratory remained open until his retirement in 1944.

In 1899 Chapman, who had excellent mathematical ability, published a paper of fundamental importance on maximum explosion-rates. Five years later similar results were obtained by Jouguet, and the two names have usually been associated in this field. The theory was a development of the mathematical results of Riemann and of Hugoniot, which showed that a discontinuity or 'shock wave' of very high velocity is set up in an explosion. This theory has proved both sound and valuable, and is still basic for modern work on explosion velocities. Chapman used it for calculating velocities for mixtures of nitrogen with electrolytic gas which were in excellent agreement with the experimental findings of Dixon; but since the theory required the knowledge of the magnitudes of high-temperature specific heats, which were then not obtainable directly, it did not for some years receive adequate recognition of its importance.

Early in the present century Chapman took up the study of the photochemical combination of hydrogen and chlorine, where investigators had found confusing results due to mysterious inhibiting effects. Long 'induction periods' were observed which appeared to vary in a very capricious manner from experiment to experiment. These were traced by Chapman to the presence of minute amounts of ammoniacal or other nitrogenous compounds in the water used in the reaction vessels, and a technique of high-temperature chlorine treatment was devised to minimize the irregularities. During the following forty years he continued a systematic study of this very difficult reaction, assisted by his wife Muriel (*née* Canning) and his research pupils. The effect of surface-area of the reaction vessel in affecting the dependence of the reaction-rate on the light intensity was carefully analysed. He also worked out the 'sector-technique' for finding chain-carrier lives by measuring the change of rate with sector speed, and applied it to the photochemical combination of hydrogen with bromine. In all this photochemical work he showed very great experimental skill in the planning and technique.

His approach to research was one of equal parts of penetration and caution; he was intensely honest and fair-minded, with a very clear vision of what had and what had not been proved. Although almost a recluse in scientific work, and indifferent to its reception by others, he was personally most friendly and approachable, and beloved by all his students. His high mathematical and experimental powers were recognized by his being brought into secret work on gaseous diffusion during the Second World War as part of the 'Tube Alloy' programme.

Chapman's absorption in scientific work did not prevent him from taking a part in College and University affairs. He never sought office or power, but in such positions he showed himself a practical administrator of great ability and common sense. For ten years he undertook bursarial duties in Jesus College, and acted as vice-principal from 1926 until his retirement. He also served as senior proctor and was from time to time a member of University boards and committees, including the Hebdomadal Council.

E. J. BOWEN

Prof. Bjørn Helland-Hansen

BORN in Oslo on October 16, 1877, Bjørn Helland-Hansen's advent to oceanographical science, in which he soon became a leading international figure, was almost fortuitous. The loss of most of his fingers by frostbite, while he was still a medical student in Oslo, induced him in 1898 to turn to the natural sciences. These he pursued in Oslo and, with oceanographical bias, particularly towards physical oceanography, also in Stockholm, where he sat under Vilhelm Bjerknes on dynamic meteorology and hydrography and where he met his life-long friend, V. W. Ekman, and in Copenhagen, where he worked with the already well-known Danish oceanographer, Martin Knudsen. Thus early, too, began his friendship and collaboration with Fridtjof Nansen, which produced two notable treatises on "The Norwegian Sea" and "The Eastern North Atlantic", in 1909 and 1927, respectively.

In 1900, Helland-Hansen was appointed assistant at the Norwegian Fishery Directorate in Bergen and for ten years participated in the cruises of its research ship, *Michael Sars*, the outcome of which, in 1912, was the oceanographical classic, "The Depths of the Ocean". In 1903, however, he made his own significant contribution to the developing science when, in collaboration with J. W. Sandstrøm, he derived the method which has since been extensively used for the dynamic computation of ocean currents.

In this same period, until 1914, Helland-Hansen was the brilliant leader of international courses in ocean researches which attracted marine scientists from far and near to Bergen; and in 1906, although primarily a physicist, he became director of the Marine Biological Station in Bergen. Four years later he was given the status of a university professor and approval to build a new research ship according to his own ideas. The *Armauer Hansen*, superseded only in 1957 by the appropriately named *Helland-Hansen*, was paid for entirely by the people of Bergen.

In 1917, as the result of his advocacy, the Geophysical Institute of Bergen, now part of the University of Bergen, was founded, and it is further significant of Helland-Hansen's sterling qualities

that once again the new building occupied by the Institute in 1928 was paid for by citizens of Bergen. Besides being professor of oceanography, Helland-Hansen, until he resigned his professorship in 1946, was head of the Institute, which houses also Departments of Meteorology and of Cosmic Physics and Terrestrial Magnetism.

The scope and range of Helland-Hansen's enterprise and achievement embraced yet another project. In 1925 he was one of three trustees nominated by the testator to administer the residual estate of more than five million kroner of the late Christian Michelsen, a former Prime Minister of Norway and millionaire shipowner. As the Chr. Michelsen Fund, the estate endowed the establishment in 1930, and the maintenance, of a Chr. Michelsen Institute of Science and Intellectual Freedom. Besides compiling the statutes for its administration, Helland-Hansen, as chairman of the Board of Administrators, was for twenty-five years the presiding genius in its conduct.

He was the recipient of many honours, among which may specifically be cited the honorary rank of a Commander, with Star, of the Order of St. Olav, and the Portuguese Order of the Great Cross of St. Jago. He was doctor *honoris causa* of several universities and a fellow of numerous scientific and learned societies in Europe and America. Medals, in commemoration mostly of oceanographical research expeditions or investigators, were awarded him on many occasions. He was elected president of the International Association of Physical Oceanography in 1936 and president of the International Union of Geodesy and Geophysics in 1945.

Helland-Hansen died in Bergen on September 7, 1957, and the sympathy of countless colleagues, friends, and admirers the world over is offered to his widow, Anna Marie Krag, of Copenhagen, whom he married in 1902, and their family of one daughter and five sons.

J. B. Tait

Prof. M. Damodaran

Prof. Manayath Damodaran, who died after a prolonged illness last December, was a graduate of the University of Madras, and after some preliminary training in research at the Indian Institute of Science, Bangalore, he was awarded a Government of Madras Research Studentship. He spent his first year in Germany with Abderhalden at Halle a.S., where he worked on the preparation and enzymic digestion of myristic acid peptides, and his last two years with me at the Imperial College of Science and Technology, London. He was then, as he always remained, a quiet unassuming scholar, and he already possessed the connoisseur's appreciation of research, a quality that his friends always found so attractive, and which inspired his own students later in Madras and Poona. Until recent years his main interest was in protein chemistry and metabolism, a field in which he was a pioneer in India and by far its best exponent. At heart he was an analyst and never happier than when applying his great experimental skill to problems concerned with amino-acid analysis of proteins.

At the Imperial College he was responsible, during 1929–32, for the isolation of asparagine and glutamine from enzymic digests of edestin and gliadin respectively, an achievement which provided the first direct proof of the 'amide hypothesis' in proteins and gained him the degree of D.Sc. (London). On his return to India at the end of 1932 he was made first reader and then professor in his old University at Madras, a post he held for sixteen years. There, in spite of very limited laboratory equipment, he embarked on a series of researches which soon made him one of the foremost biochemists in India. One may mention his work on phosphopeptone from casein, the isolation of canavanine from many seeds, new sources of urease, and the proteins of local foodstuffs. He also demonstrated for the first time the presence of glutamic dehydrogenase in plants, which he found in germinating seedlings. The results of all these valuable researches were accepted for publication in the *Biochemical Journal*.

In 1948 came the call to the new National Chemical Laboratory in Poona, where he was invited to assume directorship of the Biochemical Department and later the deputy-directorship of the Laboratory. At first the task was rather an uphill one, as accommodation was limited and equipment scarce. But in the early 1950's, with the new building in operation, conditions improved, and during his last five years or so Damodaran had at his disposal a laboratory as well equipped as any in Europe or America. The National Chemical Laboratory had been created to fulfil a national need, and Damodaran never lost sight of this aspect of his job. In the early stages of its development, proteins had to be relegated to the background and prominence given to problems that might have economic or medical application. For example, he bred a remarkably active and reliable strain of *Aspergillus niger* for the production of citric acid from sugar, and his process based on it is now in commercial operation. The synthesis of ascorbic acid from sorbitol, with a 99 per cent intermediary yield of sorbose, has also passed the pilot stage. Another important line he introduced was a gelatin plasma substitute preparation, based on a tryptic digestion, which has already been tested clinically with excellent results. Damodaran entered whole-heartedly into the work of the National Chemical Laboratory, and his retirement through ill-health in the summer of 1956 was deeply regretted by the Director and all his staff. All who knew him in Britain and India will mourn the passing of a very lovable colleague.

A. C. Chibnall

Prof. Claude Fromageot

Claude Fromageot, director of the Laboratory of Biological Chemistry at the Faculté des Sciences, Paris, since 1946 and professor of biochemistry at the Sorbonne since 1954, died on January 10, at the age of fifty-eight. The unexpected loss of this distinguished scholar comes as a great shock to his many friends all over the world.

Fromageot received his early scientific education at the Institut National Agronomique. After a year at the Collège de France, he spent a further year as assistant to Victor Henri at Zurich. In 1928 he went as a Rockefeller Fellow to Berlin-Dahlem, where he worked in the laboratory of Carl Neuberg. In 1929 he became director of the Biochemical Laboratory at the Faculté des Sciences at Lyons, and there he remained (with an interruption of ten months in 1933 spent at the University of Wisconsin, in Madison) until he went to Paris in 1946.

His early work was devoted mainly to the study of bacterial fermentations, particularly to the relation between fermentation and respiration in *Propionebacterium pentosaceum*. In later years he became

interested in the study of the chemical composition of proteins endowed with biological activity; for example, of lysozyme and of the pituitary hormones. Some of his more recent results in this field were presented at Bristol in April 1956, when he took part in the Colston Research Society Symposium on the neurohypophysis.

Fromageot's name is most intimately connected with our present knowledge of the metabolism of sulphur, both in micro-organisms and in higher animals. Much of this work was reviewed in his Harvey Lecture, given in New York in 1953. One of the main advances that we owe to him and his colleagues is the recognition of the central position held by cysteinesulphinic acid in the degradation of cysteine. They discovered and investigated a number of enzymic reactions in which this important intermediate metabolite takes part. The role of vitamin B_6 in these reactions and the action of hormones on the enzymes involved have been studied in his laboratory. Many of these results are embodied in the "Colloque sur la Biochimie du Soufre", the outcome of a gathering held in May 1956 at the Station Maritime, Roscoff, under the auspices of the Centre National de la Recherche Scientifique, where Fromageot and his colleagues discussed outstanding problems with other workers in this field. Here his unique mastery of the subject was evident, and this volume will now serve to remind us of some of his more recent achievements and of his aims. At the time of his death, Fromageot was busy planning another session on sulphur metabolism for the Fourth International Congress of Biochemistry, to be held at Vienna this year.

Fromageot did much to strengthen international co-operation in research. He travelled widely and lectured in many countries, helped by his great linguistic abilities. Biochemists everywhere owe him a debt, as one of the founders of *Biochimica et Biophysica Acta*, and as the president of the Organizing Committee of the Second International Congress of Biochemistry, held at Paris in 1952.

In the remarkable development of French biochemistry in the post-war years, Fromageot played his full part. Some of his earlier colleagues followed him from Lyons to Paris; later his name attracted an ever-increasing number of workers from France as well as from many other countries. He was able in recent years greatly to develop his laboratory from its modest beginnings and to provide it with modern equipment. It is sad to think that his untimely death did not allow him to direct for a longer period what had grown into one of the world's leading centres of biochemical research. H. BLASCHKO

NEWS and VIEWS

Entomology at McGill : Prof. E. M. DuPorte

PROF. E. M. DUPORTE, who is retiring from the chair of entomology at MacDonald College, McGill, was born on the island of Nevis in the British West Indies and received his first college education at Basseterre on St. Kitts. He went to Canada in 1910 as a student at Macdonald College and has been attached to that institution either as a student or as a member of the staff throughout his academic life. He took his Master's degree in 1914 and his Ph.D. in 1921. Morphology became his principal interest, and his world-wide reputation was earned in this field. Prof. DuPorte has played an important part in establishing and maintaining the reputation of Macdonald College as a graduate school. He taught a remarkably wide range of subjects: ecology, protozoology, histology, parasitology, insect taxonomy, morphology, physiology, comparative vertebrate anatomy and embryology, and was one of the two members of the committee responsible for the establishment of the present Institute of Parasitology at Macdonald College. In spite of his wide range of interests in his own subjects, he has still found time for other activities, and is a keen golfer as well as a puppet player who builds and handles his own puppets. His friends and students thoroughout Canada will wish him a happy and enjoyable retirement.

Dr. D. K. McE. Kevan

THE appointment of Dr. D. K. McE. Kevan to succeed Prof. DuPorte at Macdonald College, McGill, will be welcomed by his many friends in Britain and Europe. Dr. Kevan graduated from the University of Edinburgh with first-class honours in zoology in 1941, and proceeded to the Imperial College of Tropical Agriculture, Trinidad, where he obtained his associateship in 1943. He was then appointed to the Colonial Service, and stationed in Kenya, where he became interested in the problems of the taxonomy of locusts and other bush hoppers. These have remained his abiding interest, and in a series of able papers he has undertaken considerable revision of the classification of certain Orthoptera, especially Chrotogonus, and has brought some degree of order to what had been a confused and tangled field.

He returned to England in 1948 as the senior member of the agricultural zoology section of the youngest Faculty of Agriculture in Britain, at the newly established University of Nottingham. In this, his first teaching post, he quickly established a reputation as an able teacher, and he played an active part in developing the curriculum for the new structure of the degree. He has been active both in the prosecution and in the encouragement of research, and a remarkable stream of papers has flowed from his department. His work in taxonomy has been assisted by a wide knowledge of foreign languages which is becoming unusual in a scientist, and papers in both German and French testify to his fluency. More recently he has become interested in soil zoology and has developed an effective undergraduate course in this field, while his own key for the identification of soil-inhabiting fauna, published with the Proceedings of the Second Nottingham Easter School in Agricultural Science, constitutes something of a classic. A critical and independent mind, he has been an admirable tutor, whose succinct reports on the vagaries as well as the virtues of both male and female students will be sadly missed by his colleagues at Sutton Bonington.

Civil Engineering at Nottingham : Dr. R. C. Coates

DR. R. C. COATES, who was appointed to the newly established chair of civil engineering in the University of Nottingham on January 1, began his education at

New Mills School and the Herbert Strutt School, Belper, Derbyshire. After a period of articled pupillage with Waude Thompson, borough engineer and surveyor, Mansfield, Nottinghamshire, Dr. Coates entered University College, Nottingham, and read for a degree in civil engineering. He then worked with Messrs. Lehane, Mackenzie and Shand, Ltd., as an engineer on factory construction for the Ministry of Supply, before joining the Corps of Royal Engineers during the Second World War, in which he served in the Mediterranean theatre. On demobilization, he worked as an engineering assistant to Mansfield Corporation, until appointed lecturer in civil engineering at University College, Nottingham, late in 1946.

He has carried out research on the fatigue strength of compression-type coil springs, and was awarded the Ph.D. degree of the University of Nottingham in 1953. In the same year he was appointed senior lecturer responsible for civil engineering in the joint Departments of Civil and Mechanical Engineering. Dr. Coates's research has included the fatigue of metals and structural analysis. In recent months he has co-operated with Mr. C. E. E. Gibson, county architect of Nottinghamshire, in the design of buildings to resist mining subsidence, and with Mr. L. E. Richardson, chief civil engineer to the East Midlands Division of the Central Electricity Authority, on the design of the experimental power station using coal gasification at Newman Spinney.

National Physical Laboratory, Ship Division : Dr. F. H. Todd

Dr. Frederick Henry Todd has been appointed superintendent of the Ship Division of the National Physical Laboratory, in succession to the late Dr. J. F. Allan (*Nature*, **180**, 68; 1957). Dr. Todd, who graduated from King's College, Newcastle upon Tyne, was at the National Physical Laboratory for twenty years before going to the United States in 1948 to become chief naval architect at the David Taylor Model Basin, Washington, D.C. Before the Second World War, Dr. Todd did much work on hull and propeller design and hull vibration for all classes of merchant ships and among his war-time activities were the testing and development of units of 'Mulberry' harbour. While in the United States he was responsible for the technical direction of the U.S. Bureau of Ships' hydrodynamics research programme in a variety of fields, including research into the hull-form of single-screw ships. Dr. Todd is returning to the National Physical Laboratory at a time of great activity in the Ship Division. The new Ship Hydrodynamics Laboratory, now under construction at Feltham at a cost of £2 million, together with present facilities, should make the National Physical Laboratory one of the best-equipped establishments in the world for ship research work. Dr. Todd spent his last year at the National Physical Laboratory before going to Washington working on a preliminary design of the main features and layout of this Laboratory.

British Trust for Ornithology : Mr. K. Williamson

The British Trust for Ornithology has received a five-year grant from the Nuffield Foundation, enabling it to appoint a migration research officer to carry out the work of analysing past observations and to make recommendations for the future. Mr. Kenneth Williamson, who has accepted the appointment, was during 1948–56 the director of the bird observatory on Fair Isle (between Orkney and Shetland) and last year spent a season on St. Kilda as warden for the Nature Conservancy. Previously he had extensive museum experience and served during the Second World War in the Faeroe Islands. During his time on Fair Isle, Mr. Williamson not only carried out extensive bird-ringing activities and day-to-day observations, but also made a particular study of the effect of the weather on migratory movements. He also studied the ectoparasites of birds as providing a possible clue to their place of origin and for several years he followed the fortunes of a breeding colony of the parasitized Arctic skua, a bird of great interest to biologists because of its two plumage phases. Mr. Williamson's first task will be to arrange for the copying by some photographic method of the massive observations accumulated by the bird observatories. In June he, with other officials of the British Trust for Ornithology, will attend the twelfth International Ornithological Congress in Helsinki and will read a paper on the work of the British bird observatories.

The International Atomic Energy Agency

A number of offers of fissionable materials, radio-elements and special materials for reactors, and fellowships and training facilities, have been officially communicated by member States to the headquarters of the International Atomic Energy Agency at Vienna, for use in atomic energy programmes to be carried out under its auspices. The prices and conditions on which the materials are to be made available to the Agency have yet to be determined. Canada has informed the Agency that, for several years at least, it could provide the natural uranium necessary for its atomic energy programmes, while India states that it could supply all the thorium needed; Ceylon has offered 30 tons of refined monazite of about 9 per cent thorium content; Norway has offered to supply isotopes produced in the Norwegian reactor at Kjeller, which is operated in collaboration with the Netherlands, and special reactor materials such as niobium, aluminium and molybdenum; Portugal has made available to the Agency 100,000 kgm. of uranium oxide in concentrate form; South Africa is prepared to supply uranium oxide concentrates, beryllium, lead, tantalum, cadmium, lithium, vanadium, chromium and nickel; the U.S.S.R. has offered 50 kgm. of contained uranium-235 in any concentration up to 20 per cent, and is prepared to make available further supplies of fissionable and other materials; the United Kingdom has offered 20 kgm. of contained uranium-235; and the United States of America has offered 5,000 kgm. of contained uranium-235, and will also make available nuclear materials equal in quantity to the total amount of such materials supplied by other members of the Agency, and on equivalent terms, up to July 1, 1960. Contributions of 250,000 dollars have also been offered to the fellowships fund and several member States have placed at the disposal of the Agency fellowships and training facilities to be taken up in the countries offering them. The United States has also announced its intention of presenting a technical library to the Agency.

Molecular Physics

The editor, Prof. H. C. Longuet-Higgins, and the associate editor, Dr. J. H. van der Waals, of the new

journal, *Molecular Physics* (1, No. 1; January 1958. Pp. 98. Published quarterly. Annual subscription: 95*s*.; 13.30 dollars. Single issues: 25*s*.; 3.50 dollars. London: Taylor and Francis, Ltd., 1958), state in their brief editorial to the first number that the subject of molecular physics occupies a key position in modern science and that the frontier between physics and chemistry is disappearing as the methods of physics are brought to bear on the problems of chemistry. Probably not all chemists and physicists would agree with this rather bold statement; nevertheless they would agree that the introduction of a periodical devoted solely to contributions on the structure and physical properties of molecules is timely. Papers on molecular structure and dynamics, the electric and magnetic properties of molecules, and the processes of molecular excitation, ionization and dissociation, and the equilibrium transport and relaxation properties of molecular assemblies, will be particularly welcome, in addition to research notes. The first number contains ten articles and one research note. These deal with such subjects as nuclear magnetic resonance in substituted ethanes; dipole moments of azines; critical opalescence in solid solutions; and six papers are devoted to theoretical problems, mainly of a mathematical nature, in quantum and statistical mechanics. One paper is in German, but all have abstracts in English, French and German. The format is similar to, and of the high standard associated with, other such scientific journals as the *Philosophical Magazine* published by Taylor and Francis, Ltd.

Science and Education

An important statement on policy has been issued by the Committee of the Science Masters' Association (pp. 12. London: John Murray (Publishers), Ltd., 1957). Recognizing that science must be taught as a major human activity and as a cultural study of supreme importance because of its effects on human life and thought, the Committee suggests that the aims of science teaching should be three-fold: to lead pupils to observe, and to solve problems by controlled experiments, to draw conclusions from observations, and to appreciate the systematic laws and principles of science; to give knowledge and understanding of the origins and development of science, of the achievements of scientific pioneers and of the implications, now and in the future, of modern scientific and technological developments; and for science specialists, to provide a suitable preparation for further scientific or technological education. The Committee recommends that all pupils should devote the same time to science subjects up to the end of the fifth-form year; that all sixth-form pupils should follow a cultural course in science and that subject-specialization should be retained in sixth forms and that science syllabuses at Advanced Level should be reduced in factual content. The recommendations raise many problems of syllabuses, of teaching methods, of suitable training for science teachers, and of examinations which will be examined in a future report.

Clouds on Filmstrip

Two filmstrips entitled "Clouds", accompanied by a 20-page booklet of lecture notes by F. H. Ludlam and Dr. R. S. Scorer of the Imperial College of Science and Technology, London, have been produced by Diana Wyllie, Ltd. (18 Pont Street, London, S.W.1), in co-operation with the National Committee for Visual Aids in Education. In recent years much has been learned about the motions of the air and properties of the water droplets and ice crystals which compose the clouds, the growth and decay of which can be used to exemplify many branches of physics. The filmstrips, which are in colour, and made in many cases from photographs of great beauty, are chosen principally to illustrate the process of development of various types of cloud rather than their classification. The colour suffers slightly in the reproduction process, which, however, also tends to increase the contrast between cloud and sky, with advantage. The filmstrips, which deal respectively with haze (in relation to condensation nuclei), convection clouds and ice clouds (24 frames) and with layer, wave and billow clouds, with three explanatory diagrams (25 frames), are intended chiefly for use in schools and universities.

Nucleonic Thickness Gauge

Baldwin Instrument Co., Ltd., Dartford, Kent, has published details of a new nucleonic thickness gauge for use in the cold-rolling of copper, brass or steel strip. The instrument can be used for thicknesses of steel up to 0·40 in., which is claimed to be about twice the upper limit for the normal β-ray gauge. This increased range is obtained by using bremsstrahlung emitted when β-rays from strontium-90 impinge on a metal target. The intensity of the radiation after passing through the strip, which is related to strip thickness, is measured by the intensity of the scintillations produced in a sodium iodide crystal. The instrument would appear to be well suited to automatic gauge control, for which it feeds a bridge circuit that indicates the deviation of thickness from any desired value. When this deviation reaches a predetermined level, the screw-down mechanism of the mill is brought into operation. The intervals during which no strip is passing through the mill are utilized for automatic standardization.

Bibliography of the Mysidacea

A useful "Bibliography of the Order Mysidacea", which is carried up to the end of 1955, has recently been prepared by Joan Gordan (*Bull. Amer. Mus. Nat. Hist.*, 112, 279; 1957). It is divided into three sections; the first, containing about 1,180 entries going back to O. F. Muller (1776), is a list of references arranged alphabetically. The second part is a list of the recorded species arranged in alphabetical order in their genera, which again are arranged alphabetically and grouped under five families. Under each species are listed the relevant page references in order of their date of publication. This arrangement makes it very easy to refer to the literature of any species for it includes the synonymy by cross-reference. The author points out that the work is not intended as a contribution to the systematics or taxonomy of the order and accepts the works of W. M., and W. M. and O. S. Tattersall (both of 1951) for these purposes. The third part arranges the literature under ten arbitrary but acceptable headings. That for distribution is subdivided into "Fresh and Brackish Water" and "Oceanic", and then each category is further divided into geographical regions. The printing and format are of the usual excellence of the *Bulletin* and the author is to be congratulated on a commendable contribution that will save future workers on the order a great deal of time.

Mond Nickel Fellowships

The Mond Nickel Fellowships for 1957 have been awarded to Mr. E. J. Williams (John Summers and Sons, Ltd.) and Mr. R. J. D. Acheson (Mufulira Copper Mines, Ltd.). The Committee now invites applications for Fellowships of an approximate value of £900–£1,200 for 1958. Fellowships will be awarded to selected candidates of British nationality with degree or equivalent qualifications to enable them to obtain wider experience and additional training in industrial establishments, at home or abroad. Further information can be obtained from the Secretary, Mond Nickel Fellowships Committee, 4 Grosvenor Gardens, London, S.W.1. Completed application forms are required by June 1.

Progress in Atomic Power

The United Kingdom Atomic Energy Authority is to hold a Conference at Harwell on June 11, at which recent developments in nuclear reactor technology will be discussed with representatives of British industry. Accommodation will be available for about two hundred representatives from industry. Requests for further details and for reservations should be made to the Director (Industrial Liaison Office), Building 329, Atomic Energy Research Establishment, Harwell, Nr. Didcot, Berkshire, not later than March 15.

Gordon Research Conferences

The Gordon Research Conferences for 1958 will be held during June 9–August 29 at Colby Junior College, New London, New Hampshire; New Hampton School, New Hampton, New Hampshire; and Kimball Union Academy, Meriden, New Hampshire. The Conferences, established to stimulate research in universities, research foundations and industrial laboratories, consist of informal meetings, scheduled lectures and free discussion groups intended as a means of disseminating information and ideas which otherwise would not be realized through the normal channels of publication and scientific meetings. No publications are prepared as emanating from the Conferences, attendance at which is limited to one hundred persons. The programme includes ceramics, chemistry, structure and physiology of bones and teeth, magnetic resonance, nuclear chemistry, radiation chemistry, toxicology and safety evaluation, and corrosion. Requests for additional information, or applications to attend, should be addressed to W. George Parks, Director, Department of Chemistry, University of Rhode Island, Kingston, Rhode Island.

Aeronautical Research

The Combustion and Propulsion Panel of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, will hold its third colloquium in Palermo, Sicily, during March 17–21. The meeting will be largely devoted to consideration of current propulsion problems. Five themes will be developed during the meeting, with one day devoted to each. They are: power plant requirements related to aircraft mission; interaction of the combustion systems with other engine components; noise; combustion; aerophysical chemistry.

The Group's Wind Tunnel and Model Testing Panel will also sponsor a meeting, in Freiburg im Breisgau, Germany, during April 22–25. The subjects which will be discussed during the four-day meeting will include the historical development of ballistics, high-velocity guns, range techniques and long-range missiles.

Lady Tata Memorial Trust Scholarships and Fellowships

The Trustees of the Lady Tata Memorial Fund invite applications for grants, scholarships or fellowships for research on diseases of the blood, with special reference to leukæmia, in the academic year beginning on October 1. In view of the affinity between leukæmia and other forms of neoplastic disease, candidates with programmes of research on any aspect of malignant disease which may throw incidental light on problems of leukæmia will be eligible for consideration. Grants of variable amount are made for research expenses or to provide scientific or technical assistants for senior workers. Scholarships are awarded for the personal remuneration of workers carrying out approved research under suitable direction; their normal value will be £600 per annum. In addition, the Trustees may award one or more Lady Tata Memorial Research Fellowships to workers with considerable research experience, with stipends of £1,200 per annum. Further particulars and forms of application may be obtained by writing to the Secretary of the (European) Scientific Advisory Committee, Lady Tata Memorial Trust, Chester Beatty Research Institute, Fulham Road, London, S.W.3. Applications must be submitted before March 31, and the awards will be announced by the Trustees in June. The grants, scholarships and fellowships offered by the Trust are open to suitably qualified investigators of any nationality, working in any country in which it will be possible to make payments in the coming academic year.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: H. B. Ambrose (agricultural officer, Kenya), research officer, Nyasaland; A. de K. Frampton (agricultural adviser to the controller, Development and Welfare Organizations, Barbados), deputy director of agriculture, Barbados; V. E. Gale (principal agricultural officer, Western Nigeria), assistant director of agriculture, Western Nigeria; L. Green (field officer (agriculture), Uganda), senior field officer (agriculture), Uganda; V. R. James (assistant superintendent of public gardens, Jamaica), superintendent of public gardens, Jamaica; G. S. Scott (provincial tsetse officer, Tanganyika), agricultural officer, Uganda; W. S. Steel (entomologist, Game and Tsetse Control Department, Northern Rhodesia), chief entomologist, Game and Tsetse Control Department, Northern Rhodesia; W. E. Lewis (assistant conservator of forests, Nyasaland), conservator of forests (Division of Afforestation), Nyasaland; J. L. Masson (assistant conservator of forests, Northern Nigeria), senior assistant conservator of forests, Northern Nigeria; C. A. M. Nash (assistant conservator of forests, Northern Nigeria), senior assistant conservator of forests, Northern Nigeria; I. Paul (assistant conservator of forests, Sierra Leone), senior assistant conservator of forests, Sierra Leone; J. D. Todd (assistant conservator of forests, Mauritius), assistant conservator of forests, Northern Rhodesia; L. H. Myers (assistant director of surveys, Jamaica), supernumerary deputy director of surveys, Jamaica; P. D. L. Guilbride (veterinary

investigation officer, Jamaica), deputy chief research officer, Uganda; M. A. Petris (veterinary officer, class 2, Cyprus), veterinary officer, class 1, Cyprus; P. J. Sheehy (veterinary officer, Northern Rhodesia), deputy director of veterinary services, Northern Rhodesia; E. Jones, chemist, Agricultural Department, Northern Nigeria; Lieut. Col. C. H. Keenlyside, land settlement officer, Nyasaland; B. H. Kenten, biochemist, West African Cacao Research Institute, Ghana; J. F. Longworth, agronomist, West African Cacao Research Institute, Ghana; W. I. Powell, agronomist, Somaliland; W. Smith, supernumerary agricultural engineer, Mauritius; D. G. Thomas, senior botanist, Uganda; W. J. Evans, assistant conservator of forests, Northern Nigeria; C. S. Feilberg, assistant conservator of forests, Northern Nigeria; B. J. Rushton, chemist, Geological Survey, Tanganyika; R. C. Sansom, assistant geologist, British Guiana; S. S. Brunton, veterinary officer, Northern Rhodesia; P. B. Capstick, veterinary research officer, Kenya; J. Dickson, veterinary research officer, Federation of Nigeria; D. G. Erskine, veterinary research officer, Federation of Nigeria; O. G. H. Karst, veterinary officer, Northern Nigeria; K. A. Ross, veterinary officer, Northern Rhodesia; L. A. Stephens, veterinary officer, Kenya.

University News: Glasgow

Prof. J. Monteath Robertson has been granted leave of absence to enable him to hold a visiting professorship in the College of Chemistry at the University of California, Berkeley. He will give a short course of lectures on the chemical significance of recent developments in crystal analysis, and will be away for about one month from the middle of March. Leave of absence has also been granted to Dr. E. Gelles for six months, during which time he will hold a research fellowship at Brandeis University, Waltham, Massachusetts. Dr. G. A. Sim has been appointed to a lectureship in chemistry, and Dr. W. M. Fairbairn has resigned his lectureship in mathematics in order to take up a lectureship at the Manchester College of Science and Technology.

London

Dr. H. G. Eggleston, lecturer in the University of Cambridge, has been appointed to the University chair of mathematics tenable at Bedford College. Dr. Mary Barber has been appointed to the University readership in clinical bacteriology tenable at the Postgraduate Medical School of London and the title of reader in mathematics in the University of London has been conferred on Dr. M. A. Jaswon, in respect of his post at the Imperial College of Science and Technology.

Announcements

Dr. H. R. C. Pratt has recently taken up an appointment as leader of the chemical engineering section in the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization. Dr. Pratt was formerly chief scientific officer at the U.K. Atomic Energy Research Establishment at Harwell and was senior group leader of the Chemical Engineering Division.

The Trustees will consider in June applications for a Ramsay Memorial Fellowship for advanced students of chemistry. The value of the Fellowship will be £600 per annum, to which may be added a grant for expenses of research not exceeding £100 per annum. The Fellowship will normally be tenable for two years. Further information can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1. Completed applications must be received not later than April 18.

A symposium on "The Design of Teaching Laboratories in Universities and Colleges of Advanced Technology" will be held at the Royal Institute of British Architects on March 14. The chairman will be Sir Keith Murray. Further information can be obtained from the Secretary, Royal Institute of British Architects, 66 Portland Place, London, W.1.

An informal discussion on "The Practice of Light Scattering" will be held in the Chemistry Lecture Theatre, Chemistry Department, University of Birmingham, on April 25. The discussion is intended to be entirely informal and to consider the experimental techniques employed in applying the light-scattering method to the study of solutions of both synthetic and biological macromolecules. Further information can be obtained from Dr. F. W. Peaker, Chemistry Department, The University, Birmingham 15.

An international congress on nuclear physics will be held in Paris, during July 7–12, under the patronage of the International Union of Pure and Applied Physics and of Unesco. The title of the congress is "Low Energy Nuclear Interactions and Nuclear Structure". Its purpose is to gather theoretical and experimental information in the energy range lower than the threshold for meson creation. Further information can be obtained from the Congrès International de Physique Nucléaire, Institut du Radium, rue Pierre Curie, Paris, 5 ème.

The Linnean Society of London is to hold a symposium on the biological uses of the electron microscope on March 28, with a possible extension to the morning of March 29. The object of the meeting is to enable biological workers (including those engaged in the cognate medical sciences) who are not themselves experts in the use of the electron microscope to learn something of the biological applications of that powerful research tool. Biologists who are not members of the Society should inform the General Secretary, Linnean Society, Burlington House, London, W.1, before February 28 if they desire to attend.

The Federation of British Industries is to hold a Conference on Nuclear Energy under the chairmanship of Sir Claude Gibb (managing director, C. A. Parsons and Co., Ltd.) at the Grand Hotel, Eastbourne, during April 10–12. The Conference, which aims at conveying an understanding of the industrial potentials and applications of nuclear power to directors of firms in fringe industries, will include a visit to the Atomic Energy Research Establishment at Harwell. Further details can be obtained from the conference secretary, Mr. P. J. C. Perry, Federation of British Industries, 21 Tothill Street, London, S.W.1.

Erratum. In the communication entitled "Action of Ethylene Dibromide on Hen Gonadotrophic Hormones" by Dr. Eugenia Olomucki, published in *Nature* (**180**, 1358; 1957), the daily amount of follicle-stimulating hormone injected into hens was 1·4 mgm. (and not 14 mgm., as printed).

BRITAIN'S COAL AND ITS FUTURE

THE pace at which the material conditions of civilization are changing at the present time is unique in recorded history. Prof. Arnold Toynbee has contended that throughout the 5,000 years up to the past century these conditions, and the human outlook, remained fundamentally the same. But the rapid acceleration that began with the industrial revolution is now so far-reaching that it may herald a change in kind rather than of degree in the affairs of mankind; accompanied, it is to be hoped, by an increased capacity for understanding and controlling the new environment. Though this general picture is true only of the industrial nations, none can long continue unaffected whether it participates in the process of industrialization or not. Prof. P. M. S. Blackett, in his recent presidential address to the British Association, has suggested that an investment of about £1 per head of population per annum is required initially to enable a society to 'take off' in this sense and gather the necessary momentum.

Nowhere is this acceleration more apparent than in the basic activities of fuel production and consumption. Industry has developed chiefly on energy from coal over some 200 years; oil has become important during the past forty years and nuclear energy is providing the latest example of rapid growth. Other sources of energy have been, and are likely to remain, relatively unimportant in the broad picture. Oil has natural advantages, such as its convenience in use whether in the mobile internal combustion engine or as furnace fuel; and, in addition to its energy value, the demand for certain fractions as lubricants is by no means negligible. It is thus the coal industry that may be most affected by the changing relative importance of these three sources of energy.

There is considerable misconception about the likely effects of these changes within the present century; the quantity of coal used is very great, and nuclear energy, however rapidly developed, seems unlikely to shoulder a major part of Britain's power load before the final decades. Recent authoritative forecasts have predicted that the use of coal in the United States may be at least doubled over the next twenty years, though ultimately there may be some decline in consumption. In Britain, the change is unlikely to be spectacular, but an increase is to be expected in the immediate future. The large uncertainties that necessarily attend even the most careful attempts to foresee the overall trends and the detailed shifts in the modes of coal consumption thus pose many problems, not least to those responsible for both long- and short-term research on coal utilization.

It was in relation to this background that Dr. J. Bronowski, director of the Coal Research Establishment of the National Coal Board, delivered to the Royal Institute of Chemistry the tenth Dalton Lecture, entitled "Coal and Coal Chemicals in the National Economy", at the Manchester Town Hall on October 25. The large audience comprised, as well as scientists, a wide cross-section of the public led by the Lord Mayor; and a well-designed exhibition relevant to the subject was arranged in the nearby public library by the Institute and the National Coal Board with the support of other organizations.

Dr. Bronowski's lecture consisted of a thoughtful analysis of trends in the material basis of life with special reference to fuel, their extrapolation into the future, and their bearing on current research policy. He demonstrated that the standard of living of a society is related in precise detail to its degree of mechanization; as measures of mechanization, steel and energy consumption per unit of population, representing respectively indices of material being processed and of energy used in processing it, are both satisfactory. For reasons that are obvious, food consumption as a measure of standard of living tends to rise to a maximum, whereas the rate of increase of income with increase in mechanization shows no slackening. The position of the United Kingdom on the food-graph lies near the maximum, whereas on the income curves it lies well below that of the United States and Canada, though it is high among the European countries. With each additional ton of coal or its equivalent used annually by the individual, the average income rises by approximately £60 a year.

The acceleration in energy consumption is well illustrated by the fact that half the coal used in the history of mankind has been consumed in the past twenty-five years, and half the petroleum in the past ten. Coal had traditionally been used in two ways: to provide energy, and to produce coke for steel-making—the latter a crude chemical use.

In Great Britain, only two forms of coal consumption are still increasing rapidly: electricity generation by about 80 per cent over the past ten years and metallurgical coke production by about 60 per cent; other uses are for the most part either falling, stationary, or if still increasing, decelerating rapidly. Coal production is inflexible, the increase over the whole world since 1910 having been only 40 per cent, smaller than the increase in population. Considering the two accelerating demands in this context, electricity production at its present rate of increase cannot for long continue to be based solely on coal; demand could not be met, and to attempt it would be inimical to the best use of the three main fuels. The nuclear fuels have no other large-scale application, but coal has its considerable chemical value. Moreover, the contribution of fuel to the total cost of manufactured goods is falling. This is due to the general shift from heavy towards light industry in which skill and therefore labour costs are relatively more important. A parallel tendency is from solid fuels towards the more flexible fluid forms, oil and gas. Dr. Bronowski emphasized that, owing to the exhaustion of the older seams and increased mechanization, the trends in the types of coal available are towards the following: coals yielding more volatile matter on heating but of less value in coke making; an increased proportion of small coal; and coals of increased ash content. Such lower-grade coals should

be regarded progressively, in planning for the future, as raw material for making refined fuels and chemicals rather than as fuels *per se*.

The chemical by-products of coal carbonization now of greatest importance are benzene, naphthalene and phenols; these are linked with gas and coke production. From present tendencies, Dr. Bronowski estimated a need in 1975 for 50 million tons [an estimate perhaps on the high side] of coal to make metallurgical coke, a development that will make available considerably larger amounts of these chemicals. Thus the only use of coal likely to expand considerably will—in opposition to the pattern of production—demand selectively the better classes of coking coal unless the range of coals that can be used for this purpose can be widened—an important research objective. Even with this increase, the production from coal of the three chemicals mentioned will probably be inadequate—barely half the estimated needs of their users. Moreover, the coke oven is a most expensive plant requiring a capital investment of £7·7 for each £1 of value added in the product, as compared with £2·2 average in industry. The remainder of the lecture was therefore concerned with alternative methods of producing chemicals and coke or coke substitutes from a wider range of coals.

The chemical structure of oil is more suited to flexibility in the production of raw materials for chemical industry than that of coal; moreover, research in the past has been pursued more energetically in the oil industry. Nevertheless, the constitution of coal gives it a natural advantage for the production of aromatic chemicals; and though the hydrogen/carbon ratio in coal is low, carbonization leads to disproportionation reactions, yielding volatile products of higher ratio and a carbonaceous residue. Fluid-bed conditions are more favourable to high yields of liquid products than those in the fixed bed of a coke oven, which favour secondary cracking of the products. The former type of process converts coal to a powdered char, with good yields of tar, and a rich gas; these novel tars are less suited to the current market for tar chemicals, though there is a low-price outlet in the expanding market for coal-tar fuels. Dr. Bronowski mentioned the processes, being developed at the National Coal Board's Coal Research Establishment, designed to convert such chars by briquetting to smokeless fuels for domestic use [see also Sir Charles Ellis, *Nature*, **175**, 274; 1955].

Such processes are envisaged only as an interim measure, since the demand for solid smokeless fuels may well prove ephemeral. The next step would be gasification of the char, made as described above by fluidized carbonization with production from the tar of medium oil. The gasification stage could produce alternatively a rich gas for heating or a synthesis gas for production of oil—especially the gas and Diesel oils increasingly in demand as fuels rather than light oil of high octane number, previously the main objective of the Fischer–Tropsch process. Some of the simplest and most flexible chemical raw materials now made from petroleum, such as the olefines, could also then be made as by-products during production of oil from coal. Another potential use for the char is for production of calcium carbide simultaneously with gasification at high temperature using oxygen.

Looking still farther ahead to the end of the century, the possible availability of electricity at very low cost from nuclear reactors might make available cheap electrolytic hydrogen, so that the question of direct hydrogenation of coal to fuel oil, at present uneconomic owing to the high cost of hydrogen and power, might be reopened.

Dr. Bronowski concluded by emphasizing that these were his personal views on the future of coal. In brief, the post-war energy famine is ending; the industrial energy demand will ultimately be carried chiefly by atomic energy; small and high-volatile coal thus set free could be used for making solid smokeless fuels, and later, fluid fuels and chemicals.

In broad perspective, Dr. Bronowski's review of trends and portents corresponds closely with views increasingly coming to be accepted in Britain, and indeed in other European countries (see, for example, D. W. van Krevelen, *Chem. and Indust.*, 546; 1957). It will be conceded that there is likely to be an important shift in the use of coal within a few decades towards gasification and the production of oil. Opinions may differ, however, as to the advantage of a two-stage process, in which fluidized carbonization of coal precedes gasification of the char, over gasification of the coal in a single stage; this will depend partly on the commercial value of the tar produced by the first method. It may also be expected that for many years an appreciable amount of small coal of high ash content will be burnt in boiler plant, increasingly automatic, to provide heat and power for small industries. The extent of this will be affected by the siting of industry: for much of the heat inevitably wasted in a nuclear power station could ultimately be used as process heat in neighbouring factories. A large-scale outlet for higher-grade waste heat might, in fact, be provided by the gasification of coal or char, as suggested especially in the United States; the external source of heat would lead to many economies if it could be provided at not less than 900° C., to maintain an endothermic reaction between carbon and steam. The prospects of success appear, however, to be small (see J. V. Dunworth, "The Future of Nuclear Power", Inst. Gas Eng. Copyright Publ. No. 513; 1957).

One other point should be mentioned: not only is the coke oven, as Dr. Bronowski stated, a most expensive plant; the whole present sequence of steel making, using coke oven, blast furnace and open-hearth furnace, is costly and indirect, since it embodies three major stages and excess carbon introduced in the second has to be removed in the third (though for making special steels retention of this stage in some form would probably be necessary). It is quite possible that a successful single-stage process (see Sir Charles Goodeve, *Advanc. Sci.*, 13, 23; 1956) might be developed before the end of the century; and if such a process proved effective and economic on an industrial scale it would seem likely that from that time onward only sufficient coke ovens to maintain supplies of foundry coke might be replaced. Their normal life being of the order of twenty years, one must envisage a possibility—no more at present—that the demand for metallurgical coking coals might then fall to a small fraction of its maximum level within some twenty years. Whether this will happen, and when, will determine whether a shortage (other than local) of coking coals is likely to develop, and therefore the importance of research—necessarily in the immediate future—on the production of metallurgical coke from coals at present unsuitable. In the writer's judgment, such research should be continued but regarded as an urgent and possibly short-term activity.

I. G. C. Dryden

SITING OF NUCLEAR POWER STATIONS

IN a debate on the siting of nuclear power stations initiated in the House of Commons on December 19 by Mr. A. Blenkinsop and Mr. T. W. Jones, the Parliamentary Secretary to the Ministry of Power, Mr. D. Renton declined to comment on the project for a nuclear power station in Merioneth because the Minister had already decided to hold an inquiry; but he gave a full account of the procedure for preserving the amenities of the countryside so far as the Ministry of Power is concerned which was distinctly reassuring. Mr. Renton recognized the serious conflict and dilemma which arises, and assured the House that the limited possibilities of using land already developed or waste were not overlooked. In selecting the four sites already chosen and in choosing the remaining eight before the end of 1966, a preliminary general suggestion by the Central Electricity Authority is followed in each case by the search for a particular site by the Authority, and then by application to the Minister of Power, usually with a public inquiry before the Minister gave his decision.

Throughout the three stages there are certain limiting factors. First is the purely economic one, requiring nuclear power stations to be sited where the greatest economic benefit may be secured—in regions where the cost of coal is highest, remote from coalfields. Second are safety considerations, and the Government is adhering to the policy of avoiding built-up areas. Furthermore, such power stations require large quantities of cooling water, as much as 35 million gallons an hour for the stations now contemplated, solid foundations for the very heavy buildings and plant, and an area of about 300 acres.

It is with these considerations in mind that the Central Electricity Board—and from January 1, 1958, the Central Electricity Generating Board—make preliminary studies in each area where a power station appears to be needed. These studies include a thorough consideration of the development plans of local planning authorities, of the maps of the national parks and areas of outstanding natural beauty, both of which must be avoided if possible, and a geographical study of basic physical features, such as water supplies. On the basis of these general studies, the team of technical experts of the Authority proceed to what they call site selection. This may take three to twelve months, involving consideration of every possible site in the area of search and sometimes survey before provisional selection. Besides the local planning authority, the Ministry of Housing and Local Government, the Ministry of Agriculture, the Home Office, the Air Ministry, the Ministry of Transport and Civil Aviation, if necessary the Admiralty and the War Office, the National Parks Commission and the Nature Conservancy are consulted and, after a site has been provisionally selected, the Royal Fine Art Commission. Moreover, Mr. Renton pointed out, under Section 37 of the Electricity Act, the Board, the Electricity Council and the Minister of Power must have regard "to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest, and of protecting buildings and other objects of architectural or historical interest".

They must take into account the effect of their proposals on the natural beauty of the countryside and on any such flora, fauna, features, buildings and objects. Furthermore, it is not until these studies and consultations are completed that formal application is made to the Minister for his consent. When the Minister receives such an application he is now obliged to hold a public inquiry whenever a local planning authority objects and he may do so when there is any other objection. In such an inquiry he receives expert advice from his Ministry's inspector, who sometimes sits with an inspector of the Ministry of Housing and Local Government.

Observing that a conflict of public interests could only be resolved by a Minister or Ministers, Mr. Renton said that the aim was to provide a flexible system of planning. Each planning authority had the duty of formulating a county development plan and the Minister of Housing and Local Government has certain statutory duties in respect of development plans. He and other Ministers concerned were consulted by the Minister of Power before he gave his decision on each application, and the Minister's decision, which was that of the Government, could be questioned in Parliament. Mr. Renton said that the Minister of Housing and Local Government had overall responsibility for preserving amenities under the Planning Acts and his Ministry provided the information, maps and detailed plans which helped to prevent any avoidable desecration of the beauties of the countryside. Mr. Renton did not think that the central consultative committee of amenity associations suggested by Mr. Blenkinsop would contribute anything further, and he thought there was already sufficient frequent consultation with the National Parks Commission from the inception of any scheme.

CONCRETE ROADS

AN international congress was held in Rome in October to discuss recent technical progress and achievements in the construction of concrete roads and runways. Seventeen lectures were given by prominent engineers from ten countries and reports on the subjects to be discussed were also received from many others. About 800 delegates from 28 countries attended.

The congress enabled the practice in different countries to be compared, and it was of particular interest to note where there was general agreement and where there were differences. It was generally agreed that motorways and urban expressways were desirable on grounds of economy and safety. Most countries, and in particular Western Germany and Holland which together contain 80 per cent of the motorways existing in Western Europe, have preferred concrete construction for motorways. The slab thicknesses used in most countries were comparable and were based on experience; the thick-

nesses given were expected to give adequate service; but, when discussing concrete roads other than motorways, there was not complete agreement on the expected life of the road nor on what constituted failure. Probably for this reason there were considerable differences between countries in the change in thickness recommended for different classes of traffic, in the amount of reinforcement and in the spacing of joints. For example, in Belgium reinforcement was not considered necessary for secondary roads, whereas in Britain and Switzerland reinforcement was included in designs for housing estate and rural roads.

Because of the differences in design and in the availability of materials suitable for concrete or for other types of road construction, there were large differences in the views expressed on the economy of concrete construction. In Germany, improvements in bituminous construction resulting in enhanced durability required that there should be qualitative improvements in concrete construction on trunk roads. In Belgium, which has more secondary roads in concrete than elsewhere in Western Europe, this type of construction is claimed to have the advantages of economy in construction and maintenance and of good surface texture. For housing-estate roads in Great Britain concrete roads are considered to be particularly good for carrying builders' traffic, but to require careful supervision during construction if they are to be successful. In Switzerland, concrete roads had proved to be economical for rural roads when maintenance costs were considered as well as the prime cost. The question of the economical design of concrete roads in relation to performance and maintenance costs would obviously repay further study.

Economical design was also considered of major importance for the design of runways capable of carrying the very heavy channelized traffic which was now using heavy-duty airfields. One approach to the problem was to examine the traffic volume on various sections of an airfield and to relate the thickness of the pavement to the load and number of repetitions. If traffic was classified in this way it was possible to make the thickness of mid-sections of runways 25 per cent less than that required at the ends and on the main taxiways. Another approach was to use a prestressed pavement; the construction at Maison Blanche was described and it was estimated that the cost of the 7-in. thick prestressed slab was similar to that of 13 in. of normal concrete. This would correspond to a saving of some 10 per cent since it was considered that for comparable strength a normal pavement would need to be 14½ in. thick.

It seemed to be generally agreed that the subgrade had little effect on the stress in a concrete slab if the soil was uniform and the slab was equally supported over its whole area. In practice, however, uniform support is difficult to obtain, and, compared with twenty years ago, great emphasis is now placed in all countries on the proper compaction of the subgrade and base and, in order to avoid changes in the moisture content of the soil during the life of the road, on the protection of the soil from the weather during construction. In most countries the base thickness considered necessary was greater than that generally recommended in Great Britain; but this difference may be due more to the necessity of providing sufficient thickness of construction to avoid damage by frost than to the requirement for uniform support.

A very valuable summary of the construction practice in different countries was given. There was general agreement on what constituted good practice; but there were differences, many of which were due to the desire for economy. Thus, it was agreed that the concrete should have a high flexural strength and that for this purpose crushed stone aggregates were to be preferred, but gravels were used for reasons of economy. A dense concrete was desirable for durability but plastic concrete was sometimes used for facilitating placing in order to reduce costs. Two-course construction was often employed where cheaper concrete could be used in the lower course. The development of cheaper methods of construction was thus another subject on which a study might be made.

The development of prestressed concrete for roads was discussed. Most experimental work had been done in France and Great Britain but some work had also been carried out in Germany, Switzerland and the United States. It seemed that prestressed slabs of the individual type, that is those stressed by cables, have been preferred in Great Britain and Germany, while prestressed slabs of the continuous type, that is those stressed between abutments, seemed to be preferred in France and Switzerland. It seems probable that where the abutments can be placed a considerable distance apart the continuous method is more likely to be economical, but the problem of maintaining stability against buckling and of dealing with horizontal curves needs more consideration. With the individual type of slab the major problem is concerned with joints. With both types the question of reducing subgrade friction is also of importance. The congress felt, however, that the development of prestressed concrete for roads was of great importance because of the economies it appeared likely to achieve.

Finally, there were two papers on the surface irregularity of concrete roads. The methods of measuring the evenness were different, and a plea was made for agreement on an accepted international method so that comparisons could be made easily. Although a direct comparison could not be made, examination of the two papers suggested that the riding quality of recent Danish and recent British work was of the same order of quality but that considerably more effort was required in Britain to achieve that standard. In this connexion, however, it seems probable that the differences in the methods of construction may have some effect on the ease with which good riding quality may be obtained. For example, the Danish roads are generally unreinforced while reinforcement is generally included in British roads. The rate of progress during construction would therefore normally be slower in Britain, thus making the achievement of an even surface more difficult. It is important to remember, however, that the comparison is generally made between new roads, and it appeared from the discussion that the differences in construction might lead to differences in performance so that after some years under traffic the ultimate riding quality of roads of the two designs might be different. Further information is obviously desirable about the movements of slabs under traffic.

The congress thus enabled the present practice and experience in different countries to be compared. Although there was agreement on many points it was considered that further meetings to exchange experience, with perhaps a more limited field, would be of considerable value, particularly where new developments such as prestressed concrete were concerned.

R. H. H. KIRKHAM

LIVING CONDITIONS AND HEALTH

A MEDICAL conference on "The Influence of Living and Working Conditions upon Health" was held at Cannes during September 27–29, under the chairmanship of Prof. J. Parisot, former president of the World Health Assembly, and Prof. J. de Castro, formerly president of the United Nations Food and Agriculture Organization. The French Ministry of Health and Atomic Energy Commission were represented.

In the section on nutrition the diverse ways in which food factors operate were discussed on a world level by de Castro, while Cicely Williams laid stress on the social factors that might often exceed the physiological in a given food situation. According to Yang-En-Fu, recent examination of the high cereal diet common in China had shown evidence of reasonable adequacy of its vegetable protein with consequently less necessity for substitution by meat; local vegetable foods, fortified by vitamins and minerals, could be expected to correct the main deficiencies of this diet.

D'Arcy Hart considered that the highly efficient chemotherapy now available against tuberculosis imposes some re-thinking on nutritional policy in relation to this disease in under-developed countries. It is imperative to discover whether such chemotherapy is effective in the malnourished, so that mass chemotherapy can be integrated with general social and nutritional improvements; probably host resistance to infection remains important for healing, however potent the drugs may be in the initial stages of treatment. Techniques and factors, particularly psychological, in the study of fatigue in industry were discussed by Desoille and Le Guillant in the section on work factors, while problems of industrial disease in various occupations were presented by other speakers. These include Reysek, who told of some apparently new types of pulmonary exercises being tried in Czechoslovakia for silicotics, which were suggested by observations on glass blowers.

The third main topic on late effects of ionic radiations was introduced by Lacassagne, who concluded that collective measures, which would restrict the almost inevitable increase in the chance of the total population being exposed to a supplementary dose of such radiations, should not be delayed. The results of a follow-up in 1956 on the changes in blood and bone marrow in survivors of Hiroshima were given by Kono, who said that, apart from leukæmia, significant abnormalities were found on close examination of some apparently normal persons. Peacock pointed out the possible future carcinogenic dangers from radioactive isotopes. The general view of the speakers seemed to be that practice had outrun experiment and safety tests.

The conference concluded by forming an "International Medical Association for the Study of Health and Living Conditions"*, which, it is assumed, will sponsor the recently published journal *Living Conditions and Health*, the first two numbers of which have appeared in no less than six languages.

* Secretariat: Helferstorferstrasse 4/12/III, Vienna 1.

IMMUNITY IN PARASITISM

"THE Nature of Immune Responses in Parasitism" was the subject discussed at a meeting of the Parasitology Group, Institute of Biology, on October 18, at 41 Queen's Gate, London, S.W.7. Three speakers were invited to read papers.

Dr. M. Robertson (Lister Institute) summarized the results of the investigation into the antibody response of cows and heifers to infection with *Trichomonas foetus*. This work was carried out in collaboration with Dr. W. R. Kerr, of the Ministry of Agriculture, Northern Ireland.

The parasite develops in the uterus, and antigen, probably from the breakdown of the trichomonads, passes into the lymph glands and blood stream, resulting in the production of circulating agglutinins. The antibody in the blood stream has no protective value as it does not come into contact with the trichomonads at the site of infection.

The presence of *T. foetus* in the uterus stimulates the local production of antibody, which in acute cases of the disease appears to have a brief protective value in early re-exposure to infection.

Antigen passes out from the uterus, and antibody is produced in the circulating blood; but antibody does not pass back from the blood into the uterus. Trichomonads from the uterus appear in the vagina, sometimes in great numbers. Their presence stimulates the appearance of antibody in the vaginal mucin which causes the temporary disappearance of the trichomonads from the vagina, but does not have any value in protecting the animal from re-infection.

The vaginal antibody is probably produced locally. It is of great diagnostic value.

The antibody reactions of the rat to infection with *Trypanosoma lewisi* were briefly described. The trypanocidal antibody and the growth- and division-controlling antibody, or ablastin, studied by Taliaferro were referred to, and further work on the nature of ablastin was mentioned.

Dr. E. J. L. Soulsby (Cambridge) presented work concerned with immunological responses of the host to helminth infestations.

The way in which immune mechanisms may modify naturally occurring helminth infestations was briefly indicated, with particular references to gastro-intestinal nematodes of sheep. It was shown that the degree of immunity of the host, as measured by antibody-levels, was inversely proportional to the intensity of infestation and to the level of egg production. An almost complete elimination of previously high infestations occurred in early summer, and this was associated with a marked immunological response by the host. Following the elimination of the helminths, a period of protection was established in the sheep despite persistent reinfestation.

More detailed work with *Ascaris lumbricoides* in the guinea pig showed that a marked immunity to re-infestation can be induced by administering infective stages orally or by alternative routes. With the exception of the 'metabolic products' of third-stage larvæ, non-viable worm material induced no protective immunity in the guinea pig. The critical period for the release of helminth antigen, which ultimately induces protective immunity, appears to be from four to six days after infestation. The earlier larval stages appear to be unimportant in stimulating immunity. During the period of four to six days after infection the second-stage larvæ moult, but in an immune host the growth of the larvæ is inhibited and they do not reach the size at which moulting normally occurs. Using a natural marker antibody (Forssman antibody), it was found that the period between the fourth and fifth days after infection was the earliest time at which a marked release of antigen could be expected. Since this period coincides with the commencement of moulting, the moulting process is strongly suspected as an important mechanism for the release of antigens which stimulate protective immunity in the host.

Dr. K. Mellanby (Rothamsted Experimental Station) spoke at short notice, in place of Prof. R. M. Gordon, on reactions to insect bites and infestation by mites and ticks.

Individual animals respond differently to the bites of particular insects, and the responses change with the period and intensity of the attack. Two and possibly three antigens may be involved. The first evokes a weal 5–10 min. after exposure. The second antigen produces the delayed, tuberculin-type reaction some hours after exposure. Thirdly, there may be a more serious, generalized reaction, distinct from the delayed reaction and possibly related to a third antigen. The antigens are injected with the saliva of the biting insects, but also occur in their tissues. Thus, extracts of larval, pupal and male mosquitoes may give similar reactions to the bites of adult females. Reactions to non-biting insects (for example, sensitization to locusts) are essentially similar to reactions to bites.

A previously unexposed person may not react to a first bite. However, after exposure he shows the immediate reaction to a bite, and on further exposure shows the delayed reaction as well. Generally, further exposure causes the delayed reaction to disappear, and prolonged exposure may eliminate the immediate reaction also.

The reaction of the host does not affect the feeding of most blood-sucking insects, but the feeding of mites and ticks, which may take some days to engorge, may be interrupted in sensitized hosts by the infiltration of leucocytes around the mouth-parts. Sensitization to the scabies mite *Sarcoptes* causes local œdema and the mites tend to leave their burrows; the sensitized individual may be virtually immune to scabies.

Other workers have reported differences in the reaction to bites of clean insects and those infected with parasitic diseases. In the rickettsial disease, scrub typhus, infecting bites may give characteristic local lesions not caused by uninfected mites.

JUNE MAHON

INTERNATIONAL SCIENTIFIC RADIO UNION

THE twelfth general assembly of the International Scientific Radio Union was held at Boulder, Colorado, during August 22–September 5 and was attended by more than 550 delegates and observers from twenty-seven countries. The meetings of the full assembly and of the executive and organization committees were held under the chairmanship of Father P. Lejoy, who was serving a second term as president of the Union. This was the first assembly since the recently constituted national committees in Austria, Greece and the U.S.S.R. had been formed; delegates from these countries were warmly welcomed, and they took an active part in the scientific work of all the meetings in Boulder.

As is probably now well known, the main functions of the Union are to promote and organize radio research requiring international co-operation and to encourage the setting-up of such common methods of measurement as may be required for the study of any radio phenomena, whether or not these be directly associated with the Earth and its atmosphere. The work is carried out by seven commissions, each of which is concerned with specific aspects of radio research, and ranging from measurements and standards, and the use of circuits and electronics techniques to all aspects of wave propagation, and terrestrial or atmospheric noise and the important new developments in radio astronomy.

Detailed accounts of the work of each commission will be published in due course in the "Proceedings of the General Assembly". In the meantime, the results of this work are crystallized in the resolutions which each commission made and presented to the assembly for adoption. These resolutions are being printed in the Information Bulletin of the Union, which is published by the Secretary-General at 7, place Emile Danco, Uccle-Brussels (Belgium). The most recently issued Bulletin—No. 105—contains the recommendations and resolutions of Commissions 1, 2, 5 and 6, and those of the remainder will presumably be in a later issue. A list of the commissions, with their officers and the national official members, is also given in the same Bulletin.

Prior to the general assembly in Boulder, meetings were held in New York of the Mixed Commission on the Ionosphere under the chairmanship of Sir Edward Appleton, and of the Joint Commission on Radio-meteorology with Dr. W. E. Gordon as chairman. The work of these groups is conducted in close co-operation with the corresponding commissions of the International Scientific Radio Union, namely 3, "Ionospheric Radio" and "Radio and Troposphere", of which Drs. D. F. Martyn and R. L. Smith-Rose, respectively, were re-elected chairmen.

At the closing meeting, Dr. L. V. Berkner was elected president, and it was decided that the next general assembly would be held in the United Kingdom in 1960. A revised scale of national subscriptions was introduced, and provision was made for the organization between general assemblies of international symposia on specialized subjects relating to radio scientific matters.

PHYTOCHEMISTRY

SPONSORED jointly by the Government of the Federation of Malaya and Unesco, a symposium on phytochemistry was held in the new Government chemical laboratories at Petaling Jaya, Kuala Lumpur, during December 4–8. The symposium, under the chairmanship of Prof. R. A. Robinson, was attended by sixteen overseas visitors, together with eighteen scientists representing the University, Government departments and research institutions in Malaya and Singapore.

The symposium was opened on Wednesday morning by the Hon. the Minister of Health, Mr. V. T. Sambanthan, and by the Unesco representative, Mr. Lennart Mattsson, both of whom emphasized that this was the first occasion since Malaya had achieved independence that a meeting of scientists including overseas delegates had been held in this territory and that in view of this region's dependence on plant products it was particularly appropriate that the first symposium should concern itself with phytochemistry.

Twelve original papers were presented to the symposium: "Avicennin, a new coumarin from *Zanthoxylum avicennae*", by Dr. H. R. Arthur (Hong Kong); "Constituents of *Phebalium nudum*", by Prof. L. H. Briggs (New Zealand); "Alkaloids of Apocynaceous Plants", by Dr. A. Chatterjee (India); "Preliminary Investigations on the C.N.S. Action of Indonesian *Rauwolfia* spp.", by Prof. A. J. Darman (Indonesia); "The Occurrence of some Optically Active Compounds in Anacardiaceous Exudates", by Dr. H. H. Hatt (Australia); "Testing for Anti-Arrhythmic Action of New Compounds in Dogs with Ventricular Tachycardia", by Prof. A. S. Harris (United States); "Chemical Constituents of the Plants of Coniferae and Allied Orders", by Prof. T. Kariyone (Japan); "The Isolation and Separation of Alkaloids of *Kopsia singapurensis*", by Dr. Kiang and Mr. R. D. Amarasingham (Singapore); "Recent Advances in Tea Chemistry in Japan", by Dr. Y. Sakato (Japan); "Bis-coclaurine Alkaloids from *Phaeanthus ebracteolatus*, with special reference to Phaeantharine", by Prof. A. C. Santos (Philippines); "Experimental Research on the Toxicity of Rice infected by *Penicillium citrinum*", by MM. Tran-Vy, Truong-Van-Chom and Bui-Duy-Tam (Vietnam); and "Preliminary Investigations on the Separation of Alkaloids of *Rauwolfia perakensis*", by Mr. Wan Sai Cheong and Dr. A. K. Kiang.

Surveys were presented by delegates from Australia, Hong Kong, India, Indonesia, Japan, Malaya, New Zealand, the Philippines and Vietnam describing the phytochemical work already done in their areas and outlining their future programmes. These surveys were integrated with round-table discussions of the problems associated with the collection of plants and their dispatch from field to laboratory, the chemical and biological methods used in the screening of plants for useful products and the exchange of further information between delegates on return to their own countries. The desirability of depositing specimens in recognized herbaria was stressed and the meeting expressed the opinion that in all publications from this region the herbarium number should be quoted. Unesco was asked to publish the proceedings and also to issue from its regional office in Djakarta a periodical newsletter containing items of phytochemical interest.

R. A. Robinson

THE SHIRLEY INSTITUTE

THE thirty-eighth annual general meeting of the British Cotton Industry Research Association was held at the Shirley Institute, Manchester, on October 10, with the chairman of the Association presiding. In his address, Mr. N. G. McCulloch said that he believed that the Institute could be of immense service to higher management in the field of operational, as well as technological, research. The chairman was also convinced that some kind of common policy among the directors of the 2,000 firms in the industry was essential if it were to be in a position to compete successfully in the European Free Trade area. He was very happy to be able to report considerable progress in the matter of the co-ordination of research with the British Rayon Research Association, and also to announce a generous offer by the British Man-made Fibres Producers' Committee which, subject to equal support being obtained from the industrial rayon users, would assist materially in financing the Association's work. Mr. J. Lindley, honorary treasurer, in reviewing the statement of accounts for the year, reported that although the new terms of the Government's grant-in-aid were potentially more generous, there would have to be a considerable increase in the industrial income, if the Association's funds were to achieve the full benefit.

Dr. D. W. Hill, director of research, then presented his report on the year's work which once again had shown intense activity in all branches of the Institute's activities. In selecting a few of the recent developments for comment, Dr. Hill mentioned the great success of the dust hood, now re-named the Shirley pressure point system for dust extraction, in ridding the industry of byssinosis, an occupational disease of the card room for more than 100 years. The director also referred to the complete success in prolonged mill trials of the Shirley separator for hard waste breaking-up machines, a simple and inexpensive device which could be fitted to existing machines to separate out the harder waste which could then afterwards be reprocessed. The dry feed system for the automatic size box had been further developed to give precision and accuracy, and a new automatic size box was also being developed to deal with all types of continuous filament yarns. The Shirley loom for high quality fabrics, the prototype of which had been undergoing prolonged mill trials, was now working satisfactorily. The comprehensive programme of fibre blending was yielding results which were becoming rapidly available to members. Dr. Hill also made special mention of the work on flame-proofing, the new rapid ager for colloresine printing, the intensive survey of industrial mangling, and the bulked yarn programme. He pointed out further that in spite of petrol rationing, the Institute had had almost 11,500 technical transactions with its members (against 12,000 in the previous year) including 2,999

special visits, figures which, he thought, would be of interest to those who suggested that the industry was not sufficiently interested in technical advance.

As in previous years, the Institute's laboratories were open for inspection for two days with senior members of staff available for consultation. For condenser spinners the hard waste breaking-up machine was displayed. Much of the emphasis in the spinning section was on a number of simple devices for improving quality control in the mill. Much of the fundamental work on spinning has been devoted to the preliminary stage of a programme of research with the immediate emphasis on automatic regularity control at several stages of the process.

Weavers were shown a new dobby which has been incorporated in the Shirley loom. Two sizing innovations which attracted interest were the recent developments of the automatic size box, the principle of which has now found application outside textiles.

The work on raising carried out in the Finishing Department provided a display of important information on power consumption and on the effect on the rate of raising of variations in the cloth speed. The exhibition which attracted most attention from finishers, however, was the new flash-ager, for accelerating, and in some instances improving, the development of colloresine printing. Work on industrial mangles, which is almost complete, has led to the production of an improved liquid removal process, in addition to providing data from which target figures at which to aim in plant operation can be given.

Fundamental chemical work was represented by four exhibits. Infra-red spectroscopic equipment was being utilized for investigating chemically modified cellulose; the results were shown of a critical examination of the effects of cyanoethylation on cotton; the interactions of formaldehyde with cellulose and of formaldehyde with urea are being investigated and some results were illustrated which, in addition to being of considerable chemical interest, will advance the understanding of the increasingly varied resin-treatment of textiles; and the partition chromatographic techniques which have considerably advanced knowledge of the structure of silk fibroin were demonstrated.

The Institute continues its fundamental investigations of the effect on yarn properties of blends of fibres (particularly of man-made with natural fibres) in various proportions in the yarn; work in three departments was displayed including the results of chemical treatment of various blends; another working exhibit was of the equipment for producing tailor-made synthetic filaments, the physical properties of which can be related to the chemical properties of the parent polymer.

There is a newly constituted department concerned solely with members' problems either of quality control or arising from the introduction of new fibres and processes in the mill and works. The department is staffed with physicists and chemists and textile technologists, and examples were shown of the use of spectroscopy in diagnosing biological damage, of the photochemical properties of certain new dyes and of the solution of some of the difficulties most frequently posed by members.

It is not the concern of the Institute to search for new textile products, but inevitably there are occasions when such materials are discovered during some broader research. On this occasion two such discoveries were displayed, namely, an elastic yarn made by a new process and a metallized fabric with novel optical properties. These aroused considerable interest.

Lastly, mention must be made of the continuing work on instruments for quality control which has had so great an impact on the industry in recent years, particularly since the setting-up of Shirley Developments Limited. The Company had its own display of instruments which it handles, and, in addition, there were four new instruments developed at the Institute which will shortly be handed over for exploitation.

The occasion of the annual general meeting and its two associated members' days was successful in attracting a total attendance of 800, representing 217 firms.

INFLUENCE OF ORGANIC VAPOURS ON THE CRYSTAL HABIT OF ICE

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ICE crystals grown from the vapour, both in atmospheric and in laboratory supercooled clouds, show the following remarkable variation of habit with temperature[1]: 0° C. to − 3° C., thin hexagonal plates; − 3° C. to − 8° C., needles and hollow hexagonal prisms; − 8° C. to − 25° C., plates; stellar dendrites around − 15° C.; < − 25° C., prisms.

Experiments by Shaw and Mason[2], in which crystals were grown on a metal surface under conditions in which the temperature and supersaturation of the surrounding atmosphere could be varied independently, showed that the crystal habit was determined by the temperature according to the above scheme and that variation of the supersaturation produced no systematic effects. More recent experiments[3] in which crystals are grown on a fibre suspended in the centre of a water-vapour diffusion chamber confirm this result. The habit of crystals growing along the length of the fibre, over which the temperature varies from 0° C. to − 50° C., again changes in accordance with the above scheme with dendritic crystals being limited to the temperature-range − 12° C. to − 16° C. and appearing only if the supersaturation exceeds about 10 per cent. Variation of the supersaturation over very wide limits (0–300 per cent) does not induce changes as between the essential prism and plate-like habits, but such transitions may be induced by varying the temperature by only one degree centigrade.

Fig. 1

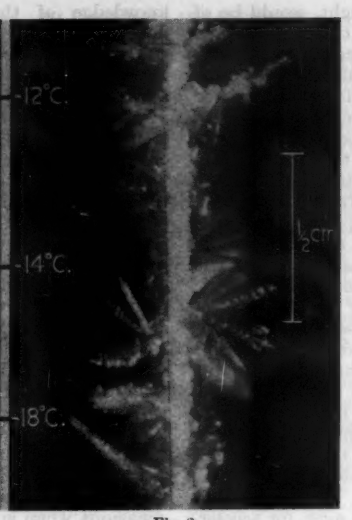

Fig. 2

The variation, at about − 14° C., of ice-crysta /habit with increasing concentrations of *iso*-butyl alcohol. Fig. 1. Dendritic growth; no alcohol present. Fig. 2. Plate-like growth; vapour pressure of alcohol 10^{-3} mb.

Fig. 3

Fig. 4

The variation, at about − 14° C., of ice-crystal habit with increasing concentrations of *iso*-butyl alcohol. Fig. 3. Hollow prisms; alcohol pressure 10^{-2} mb. Fig. 4. Reversion to dendritic growth; alcohol pressure 1 mb.

Nakaya[4] has reported that the growth forms of ice crystals may be modified by the presence of atmospheric aerosols. For example, he states that when the air is filtered to remove the suspended particles, the plate and dendritic crystals which normally occur at about − 15° C. are replaced by hollow prisms. We are unable to confirm this result. Crystals growing in our diffusion chamber show exactly the same variation of habit with respect to temperature irrespective of whether they grow in the presence of a water cloud formed by condensation on atmospheric aerosol particles or in very clean air from which all the particles have been removed by sedimentation.

However, it has been found that the presence of traces of organic vapours may profoundly influence the growth habit of ice crystals. For example, crystals grown in a diffusion chamber in which *iso*-butyl alcohol has been added to the water source show remarkable changes of shape as the concentration of alcohol vapour is varied from 0 to 1 mb. partial pressure. The vapour density of the alcohol, which diffuses downwards into the colder regions of the chamber in much the same way as the water vapour, can be estimated at each level by specifying its values at the source and sink and assuming a linear gradient in between. The concentration of alcohol vapour at the top of the chamber (the source), which is varied by changing the alcohol–water ratio of the mixture by successive factors of ten, is determined in terms of the partial pressures of the two component liquids. The vapour pressure of the alcohol at the sink, which is at − 50° C., is assumed to be practically zero. Although, in view of the simplifying assumptions, the calculated values for the absolute concentration of alcohol at each level may be slightly in error, the relative concentrations at different levels are probably reliable.

The most striking variations of crystal habit with increasing concentrations of alcohol occur between − 12° C. and − 16° C.; these are shown in Table 1 and illustrated in Figs. 1–4. When the partial pressure of the alcohol exceeds about 10^{-3} mb. the normal dendritic growth (Fig. 1) is suppressed and replaced by plate-like crystals (Fig. 2). A further rather small increase in alcohol concentration causes these to be replaced, either by hollow prisms or by needles (Fig. 3), which persist until the concentration is raised beyond 0·1 mb., above which there is a further transition to plates, and finally, at higher concentrations still, a reversion to a rather stunted form of dendritic growth (Fig. 4).

An earlier observation by Vonnegut[5], that a cloud of tiny hexagonal plate-like crystals, growing at

Table 1

Partial pressure of alcohol (mb.)					
10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	10^{0}
Dendrites					
	Plates				
		Hollow prisms and needles			
				Dendrites	

– 20° C., was transformed into hexagonal prisms by the addition of butyl alcohol at a partial pressure of about 10^{-2} mb. is confirmed. A reversion to plates occurs if the concentration of butyl alcohol exceeds about 0·2 mb. Similar transitions are also observed in the temperature-range – 8° C. to – 12° C.

The mechanism by which such sharp changes in crystal habit are produced either by small changes of temperature or by the adsorption of small quantities of certain organic vapours is not fully understood. However, experiments suggest that the habit changes, which reflect changes in the relative growth-rates of the basal and prism faces of the crystals, are due primarily to changes in surface structure, which is likely to be profoundly affected by the adsorption of foreign polar molecules, possibly by the poisoning of dislocation sites.

[1] Mason, B. J., *Quart. J. Roy. Met. Soc.*, **79**, 104 (1953).
[2] Shaw, D., and Mason, B. J., *Phil. Mag.*, **46**, 249 (1955).
[3] Hallett, J., and Mason, B. J., *Proc. Roy. Soc.* (in the press).
[4] Nakaya, U., *J. Fac. Sci. Hokkaido Univ.*, Ser. 2, **4**, 341 (1955).
[5] Vonnegut, B., *Science*, **107**, 621 (1948).

ESTIMATION OF ELECTRON AFFINITIES OF OXYGEN BY EXTRAPOLATIONS OF IONIZATION POTENTIALS

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EXPERIMENTAL determinations of the first electron affinity of atomic oxygen, $E(O \rightarrow O^-)$, have given results in unresolved conflict. A relatively short time ago a value in the range 2·0–2·33 eV. was suggested by studies of electron attachment at a hot filament and from dissociative attachment in a mass spectrometer[1]. (Data expressed in eV. should be multiplied by the factor 23·05 to obtain corresponding values in kcal./gm.-atom.) More recently, Smith and Branscomb[2] obtained the value 1·48 eV. by observing the threshold and measuring the cross-section for photo-detachment of an electron from the O^- ion. Also, Schüler and Bingel[3] have derived the values 0·98 and 1·05 eV. from spectroscopic studies. There is thus considerable uncertainty as to the correct value of the electron affinity.

In addition to experimental methods, various theoretical and semi-empirical procedures have been employed to derive electron affinities[4], and the whole problem has been reviewed by Pritchard[5]. One of the most widely used of the various extrapolation methods for the estimation of electron affinities of atoms depends on a knowledge of the ionization potentials of a series of isoelectronic ions. This type of method is considered here in connexion with the estimation of the first and second electron affinities of atomic oxygen. An indication of the consistency of the results may be obtained by comparing the sum of these electron affinities with the affinity of oxygen for two electrons, which may be evaluated by employing the theoretically calculated lattice energies of oxides in conjunction with known thermodynamic data[6,7].

Table 1. Ionization Potentials of Ions Isoelectronic with O^- and the First Electron Affinity of Oxygen

Z	Ion	Ionization potential I			
		Moore	Finkelnburg and Humbach	This work	Selected value
9	F	17·42	17·418		17·418
10	Ne^+	41·07	41·07		41·07
11	Na^{2+}	71·65	71·8 ± 0·1*	71·715*	71·715
12	Mg^{3+}	109·29	109·3		109·29
13	Al^{4+}	153·77	153·8		153·77
14	Si^{5+}	205·11	205·1		205·11
15	P^{6+}	263·31	263·3		263·31
16	S^{7+}	328·80	328·4 ± 0·1*	328·6*	328·6

Extrapolation to $Z = 8$ gives $E(O \rightarrow O^-) = 1·044$ eV.
* Interpolated values.

Table 2. Ionization Potentials of Ions Isoelectronic with O^{2-} and the Second Electron Affinity of Oxygen

Z	Ion	Ionization potential I			
		Moore	Finkelnburg and Humbach	This work	Selected value
9	F^-				3·577*
10	Ne	21·559	21·559		21·559
11	Na^+	47·29	47·29		47·29
12	Mg^{2+}	80·12	78·2 ± 0·1†	80·14†	80·18‡
13	Al^{3+}	119·96	119·96		119·96
14	Si^{4+}	166·73	166·73		166·73
15	P^{5+}	220·414	220·41		220·41
16	S^{6+}	280·99	280·99		280·99

Extrapolation to $Z = 8$ gives $E(O^- \rightarrow O^{2-})$ equals – 7·754 eV.
* Value selected by Pritchard (ref. 5).
† Interpolated values.
‡ If this term were omitted, and extrapolation carried out, the same result would be obtained for $E(O^- \rightarrow O^{2-})$, namely, – 7·754 eV.

Although the ionization potentials, I, of isoelectronic ions are the eigenvalues of a discontinuous function of the atomic number Z, the present work is based on the premise that they satisfy a continuous well-behaved function.

The best way of finding whether the table of a function is reliable is to form a table of successive differences. The onset of 'noise' in the table indicates to how many significant figures the tabulated function is reliable. The most recent set of ionization potential data for ions isoelectronic with O^- and O^{2-} appears to be that of Finkelnburg and Humbach[8]; the values together with those given by Moore[9] are listed in Tables 1 and 2. The data of Finkelnburg and Humbach in Table 1 fit a well-behaved function quite reasonably. Their data in Table 2, however, do not represent a well-behaved function, as is indicated by the early onset of 'noise' in a difference table.

Following the initial premise that the ionization potentials should satisfy a well-behaved function, the interpolated values of Finkelnburg and Humbach have been recomputed by means of the Lagrange formula :

$$f(x) = \sum_{i \neq j}^{n} \frac{\prod (x - x_i)}{\prod (x_j - x_i)} \cdot f(x_j) \qquad (1)$$

This may be rewritten as

$$f(x) = \sum_{j} L_j f(x_j) \qquad (2)$$

L being referred to as the Lagrange coefficient of the jth term. The results of the interpolations are given in column 5 of Tables 1 and 2. Although the best fit would be obtained by the use of Tchebychev coefficients, it was decided that the reliability of the data did not merit the extra work involved. (An extrapolation using weighted data may therefore be merited, but this was not done since it is uncertain which of the higher terms are most reliable.) The calculations have been performed on an electronic digital computer, the Lagrange programme being used for performing the final extrapolation to $Z = 8$.

The extrapolated value corresponding to the first electron affinity of oxygen was found to be 1·044 eV. This agrees well with the experimental results of Schüler and Bingel[3], namely, 1·05 and 0·98 eV.

The extrapolation required to obtain the second electron affinity of oxygen $E(O^- \rightarrow O^{2-})$ provides more difficulty. Morris[7] has recently derived the value − 6·63 eV. for the double electron affinity of oxygen $E(O \rightarrow O^{2-})$ from lattice-energy calculations, and it appears reasonable to regard this value as correct to within ± 0·3 eV. It follows that $E(O^- \rightarrow O^{2-})$ should be about − 7·67 eV. This may be compared with the value − 7·754 eV. obtained by extrapolating the selected values in Table 2. To assess the variation of $E(O \rightarrow O^{2-})$ on altering I_{12} in Table 2, it is necessary merely to evaluate L_{12}. This is − 17·5. Hence, if values for I_{12} of 80·12 or 80·14 eV. are adopted, I_8 is increased by 1·05 or 0·7 eV., respectively, and $E(O \rightarrow O^{2-})$ equals − 5·66 or − 6·01 eV. On the other hand, if the value of $I_{12} = 80{\cdot}2$ eV., quoted in Landolt-Börnstein[10], is taken, $E(O \rightarrow O^{2-})$ equals − 7·06 eV. The introduction of the value 80·12, 80·18 or 80·20 eV. into the difference table gives rise to considerable noise. It follows, if our major premise is to hold, that at least one *other* of the selected values in Table 2 is suspect. However, in view of the fact that the Lagrange coefficients of the middle terms are quite large, only small adjustments to these terms, about 0·02 eV., would be required to make the data satisfy a continuous function consistent with $E(O^- \rightarrow O^{2-})$ equal to −7·754 eV.

From the preceding argument it follows that the value for $E(O \rightarrow O^{2-})$ obtained by extrapolations of ionization potential values of present known accuracy, − 6·71 eV., is consistent with the value, − 6·63 eV., obtained from lattice energy calculations.

Our thanks are due to Dr. P. N. Daykin and Dr. A. J. Carr for helpful and stimulating discussion.

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MAMMALIAN CELLULOSE

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It has been shown recently that following treatment with alkaline buffers collagenous tissue contains domains in which masses of 'elastica staining material' can be observed[1,2]. Further work has shown that numerous fibres or lamellæ with a high degree of birefringence may be associated with these domains, and their presence is more clearly seen after alkali treatment of the collagen and ground substance. Such fibrous systems have now been identified as minor components of many adult human tissues, but from present observations appear rarely in infant tissue. There is also evidence that they may constitute a significant component of certain pathological tissues, for example, dermis from cases of scleroderma. Hence it is felt that the presence of these adventitious fibre species in quantity may indicate aberrant developments in the metabolism of connective tissue. Thus a study of these fibres has been made using both chemical and physical methods.

The fibres are of two types, illustrated in Figs. 1 and 2. (These illustrations show two fibres obtained from fresh bovine skin by treatment with alkali, followed by digestion with collagenase and elastase, boiling with 2 per cent acetic acid and treatment with saturated lithium bromide solution to remove residues of keratin. Dried, unfixed preparations.) The first demonstrates uniform anisotropy in all directions. Hence there is no extinction of birefringence, whether the fibre is arranged parallel or at right angles to the plane of polarization. Extinction does occur, however, if the fibre is rotated about its axis (Fig. 1). The other group of fibres (Fig. 2) is

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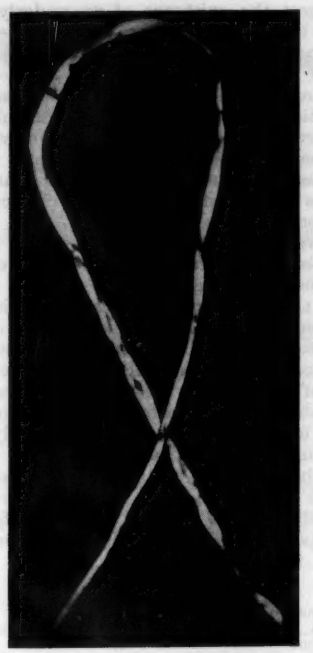

Fig. 1. Anisotropic fibre photographed in monochromatic sodium light. The birefringence is not associated with the orientation of smaller anisotropic rods, since it is not extinguished where the fibre is curved. Examined in white light the fibre shows very little dichroism in some regions. With a first-order red plate it is negatively birefringent like cellulose, and the refractive index is also of the same order as cellulose. (× 141)

Fig. 2. Fibre composed of two phases: a core oriented in one direction only, and an outer layer having helical orientation. Observations in white light indicated dichroism of the core in some regions but none in the helix, and on examination with a first-order red plate only the helix had a yellow coloration and thereby the two phases could be separated. The outer helix is much more highly oriented, being of the same order as cellulose. Some of its layers have been stripped off (shown by arrow) and two superimposed layers of the anisotropic helices (*AA*, outer layer; *BB*, inner layer) can be seen. Photographed in white light. (× 1215)

characterized by the presence of either one or two anisotropic helices wound around a core, which shows little or no birefringence.

Preparations of small quantities of fibres in a relatively pure state have been obtained by the removal of the surrounding tissue by reaction with collagenase, elastase, boiling 2 per cent acetic acid and treatment with reagents specific for the fission of hydrogen bonds, such as lithium bromide. There was no evidence that these reagents had any effect on the completely anisotropic fibres, but lithium bromide treatment of those which consisted of two clearly observable phases (the polysaccharide did not form a complete pellicle around the ground substance) caused a certain amount of swelling, accompanied by the uncoiling of part of the outer helical layer (Fig. 2).

Hydrolysates of fibre preparations showed the presence of both amino-acids and sugars. Chromatography of the hydrolysates indicated that the protein portion of the fibres had an amino-acid composition intermediate between that of collagen and elastin. The polysaccharide portion, on the other hand, consisted in the main of glucose, associated with small amounts of pentoses and amino-sugars which could be derived from mucopolysaccharides. This high concentration of glucose coupled with the solubility properties of the intact fibres suggested that the polysaccharide might well be cellulose, or some related polymer.

Optical measurements on the fibres between crossed nicols gave the refractive indices with the fibre axis parallel and at right angles to the plane of polarization of 1·586 and 1·525, respectively. The sign of this birefringence is negative, and its value, 0·061, lies close to that of ramie. X-ray examination of the fibres confirmed the presence of native cellulose (Fig. 3). Finally, infra-red spectra, although rather complex and difficult to interpret due to the simultaneous presence of both polysaccharide and protein, were not inconsistent with the above conclusions.

Microscopic examination of the angles of the helices of those fibres with a partially developed polysaccharide phase (as in Fig. 2) showed a spread about

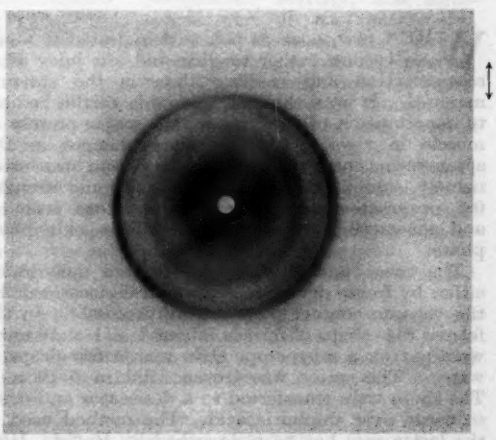

Fig. 3. X-ray diagram of aligned fibres showing a clearly defined X-ray diagram of native cellulose with an angular dispersion of ~ 75°. (Copper $K\alpha$ radiation, D = 4 cm. (on original diagram).) The direction of the fibre axis is marked on the diagram with an arrow

a mean value of 72° with a small distribution peak at about 58°. The angular dispersion of the arcs in the X-ray diagram would also appear to indicate that the cellulose was oriented at an angle in the region of about 75°, thereby showing marked correlation with the optical observations. Where extensive development of the cellulose component has occurred (Fig. 1) these helical angles cannot be measured.

Hitherto, cellulose has only been reported in the plant kingdom, and in certain lower animals such as the Tunicata. Examination of the cellulose fibres present in the tunics of the sea squirt, *Ascidiella aspersa*, has shown that, in common with the highly anisotropic fibres found in mammalian tissue, the cellulose is associated with a protein fraction which is resistant to attack by the same enzymes and chemical reagents, and which has an amino-acid analysis between that of collagen and elastin.

On the basis of these observations it may be suggested that under certain conditions cellulose may be laid down on the surface of collagen fibres. This deposition occurs initially in helical form and afterwards in a similar fashion in successive layers (Fig. 2) resulting finally in a fibre, the protein core of which is completely covered with anisotropic cellulose. Electron microscope studies of such fibres have also shown the presence of finer fibrils arranged in layers. All the fibrils in any one layer lie parallel to one another, but they lie at an angle to those in adjacent layers.

From the point of view of collagen morphology, this phenomenon is of considerable interest since it would appear to indicate that collagen degradation products are capable of bringing about the orientation of highly anisotropic elements in a helical form. This may suggest the existence of an underlying helical structure in the collagen fibre itself. A helical structure has been used for explaining the molecular organization of collagen[2,4] and has also been observed at electron-microscope level in the early stages of thermal denaturation[5]. It is interesting to postulate that a helical structure persists at all levels of organization. Cruise[6] has reported the presence in a number of animal tissues of fibres having a brittle nature. Their properties appear similar in many respects to those of the fibres reported here.

As a first indication of the presence of cellulose in mammalian tissue these observations are of fundamental biological importance, especially in view of the fact that there is a marked similarity between the protein matrix to which the cellulose is attached, in both mammalian fibres and in those obtained from the Tunicata. The existence of cellulose as a component of mammalian tissue may, therefore, have considerable significance from an evolutionary point of view, but it may also have an equally profound impact on theories of tissue ageing.

A further account of these observations will be published elsewhere.

We wish to thank Prof. R. D. Preston for electron-microscope studies and Dr. W. Horton for assistance in the X-ray examination.

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ADENOSINE TRIPHOSPHATASE AND CONTRACTION IN DEHYDRATED MUSCLE FIBRES

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WHEN raw meat or fish is dehydrated it tends to become rather tougher and less juicy after reconstitution and cooking than is the starting material. It was thought that this might be due to denaturation of actomyosin, the major protein of muscle in rigor. To investigate changes in the actomyosin, three of its properties were measured, namely, solubility in salt solutions of ionic strength 0·5 or greater, adenosine triphosphatase activity, and contractility in presence of adenosine triphosphate.

The meat and fish examined were dehydrated either by freeze drying in a vacuum desiccator or by the vacuum contact plate drying process[1,2]. In the former case strips of muscle (about 1 × 1 × 10 mm.) were put on a microscope slide with a few drops of water. The water was frozen solid in 5–10 min. The slides were transferred to a desiccator and dried *in vacuo* over sulphuric acid. The method used in the latter case has been described by Rolfe[3]. Here the foodstuff is freeze-dried for a few hours; its temperature is then slowly raised until it reaches 60° C., by which time the material is dry.

The effect of dehydration by both processes on the solubility of cod (*Gadus callarias*) muscle proteins has been investigated by Connell[4]. He found that extensive denaturation had occurred and that none of the structural proteins had remained in the undenatured state. It was also found in this work that the actomyosin of vacuum-contact plate-dried cod muscle was not soluble in 0·5 *M* potassium chloride or in 5 per cent sodium chloride if the extraction were done by allowing the ground fibres to stand overnight in the salt solution, or by blending them at half speed in an 'Atomix' with a close-fitting baffle to prevent foaming. On the other hand, when an 'Atomix' blender was used at full speed, the 'soluble' protein rose to 85–95 per cent of the total protein. This additional 'soluble' protein, however, was sedimented as the centrifugal force was increased in the range 800–16,000 *g*. It could also be removed completely by filtration through a fine paper (Whatman 42). No solubility measurements were done on meat since those on fish were so inconclusive.

The adenosine triphosphatase activity of both cod and beef was measured before and after dehydration

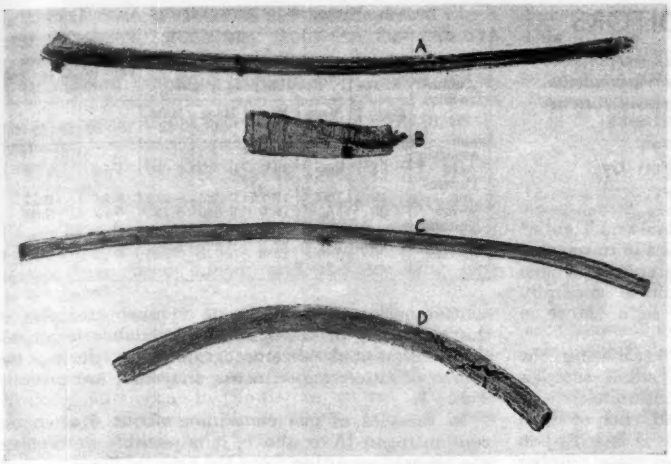

Fig. 1. Contractility of fresh and reconstituted, dehydrated, beef fibres on addition of adenosine triphosphate. *A*, fresh beef muscle fibre before addition of adenosine triphosphate; *B*, 5 min. after addition of adenosine triphosphate; *C*, dehydrated reconstituted beef muscle fibre before addition of adenosine triphosphate; *D*, 5 min. after addition of adenosine triphosphate. (× 50)

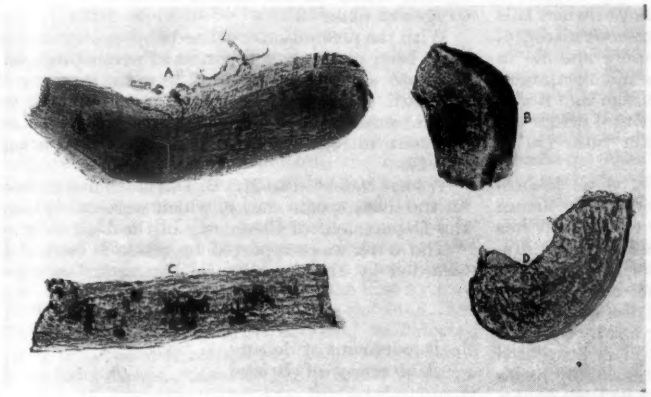

Fig. 2. Contractility of fresh and reconstituted, dehydrated cod muscle fibres on addition of adenosine triphosphate. *A*, fresh cod muscle fibre before addition of adenosine triphosphate; *B*, 15 min. after addition of adenosine triphosphate; *C*, dehydrated reconstituted cod muscle fibre before addition of adenosine triphosphate; *D*, 15 min. after addition of adenosine triphosphate. (× 30)

by the vacuum contact plate drying process. In these determinations the rate of liberation of inorganic phosphate from adenosine triphosphate by washed muscle preparations was measured with calcium as an activator. Calcium is probably not the physiological activator but it does promote actomyosin–adenosine triphosphatase without activating that of other tissue or apyrases. In every case examined, a proportion of the adenosine triphosphatase survived dehydration. In beef, the amount left varied from 40–80 per cent; in fish, about 50–75 per cent remained active. Loss of solubility and of enzyme activity are commonly used to show protein denaturation, but these results indicate that actomyosin could become insoluble in 0·5 *M* potassium chloride without losing its adenosine triphosphatase activity.

To obtain more evidence on the changes which occur in dehydration, beef and fish muscle were examined before and after dehydration for contractility in the presence of adenosine triphosphate. For this purpose, single fibres were removed by dissection with fine needles under the × 30 power of a stereoscopic microscope. These were then reconstituted in veronal buffer containing magnesium ions, and observed under the microscope while adenosine triphosphate was added. Beef fibres so treated always contracted whether they had been dehydrated by freeze-drying in a vacuum desiccator, or by the vacuum contact plate drying process. The dried, reconstituted fibres contracted to a smaller extent than the fresh and at a slightly slower rate. Like them they increased in cross-section as they shortened (Fig. 1). The contractility of dried beef fibres was not very easily destroyed by heat. Samples dried in a desiccator and heated in open dishes for 1 hr. at 22°, 37° and 55° were still contractile. At 70°, the power to contract was much reduced and at 100° it was completely absent.

The actomyosin in cod muscle fibres was much more labile. Fibres from cod fillets or steaks dried by the vacuum contact plate process never contracted in presence of adenosine triphosphate. Fibres from materials freeze-dried in a desiccator were sometimes contractile and sometimes not. The reason for this is not yet apparent though it is probably connected with the rate of freezing. Even when the fibres were contractile, they shortened less than similar fresh fibres and at a very much slower rate (Fig. 2).

From the above results it appears that cod actomyosin can be rendered insoluble by dehydration, but a large part of its adenosine triphosphatase activity, and sometimes even of its contractility, remains. Robinson had similar results with chicken actomyosin[5]. Solubility measurements are therefore not reliable criteria of denaturation though they do seem to measure some change which has occurred in actomyosin during drying.

Beef actomyosin is much more stable than that of cod. A large proportion of it is undamaged as measured by adenosine triphosphatase activity and contractility, after dehydration by freeze-drying or the vacuum contact plate process.

A detailed account of this work will be published elsewhere.

We wish to thank Mr. J. R. Bendall, of the Low Temperature Research Station, Cambridge, for his suggestion that contractility might be a useful method for studying the behaviour of actomyosin in dehydration.

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LETTERS TO THE EDITORS

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Assay of Isotopic Nitrogen by Mass-Spectrometer

In a recent communication, Capindale and Tomlin[1] have pointed out some of the difficulties in measuring accurately the abundance of isotopic nitrogen (nitrogen-15), a measurement which is generally required when this isotope is used as a tracer in biological experiments.

One of the chief difficulties in estimating the abundance of isotopic nitrogen in small samples (20–300 μgm.) is the correction for contamination by air. Two methods are commonly used, each of them suffering from some drawbacks. One is based upon a measurement of the oxygen peak at mass number 32 and, by means of a predetermined nitrogen/oxygen ratio (28/32) for air (≈5·5), correcting for contamination by atmospheric nitrogen. This method is accurate provided that all the oxygen in the sample comes from air, but is invalidated if any oxygen is formed by decomposition of hypobromite, when this is used for oxidizing the ammonia to gaseous nitrogen. The other method of correction is more specific in that it depends on measurement of the nitrogen/argon ratio (28/40); but it has the disadvantage that argon is present only in traces and experimental errors are magnified by the high nitrogen/argon ratio (≈73) in air.

Both methods have been tested in these laboratories during the course of work carried out by Yemm and Willis[2] and by Cocking[3]. More recently, it has been possible to apply corrections, based on measurements of the oxygen peak, with greater confidence by virtually eliminating the release of oxygen from hypobromite. As shown by Fleury[4], the decomposition, $2NaBrO \rightarrow 2NaBr + O_2$, is catalysed by traces of copper (Cu^{++}), but the decomposition is prevented by adding potassium iodide, which presumably forms a complex with the catalyst. Many tests have shown that no detectable release of oxygen occurs when 0·1 per cent potassium iodide is added to the hypobromite reagent. Moreover, by immersing the reaction vessel in liquid air after completion of the oxidation, it is possible to freeze out other by-products, such as nitrous oxide and carbon dioxide, which may interfere with measurements of nitrogen at mass numbers 28, 29, 30.

For routine analyses Rittenberg tubes[5], which can be fitted directly to the gas inlet system of a mass spectrometer, are convenient. By evacuating the tubes in two stages, first to about 10^{-2} mm. mercury by a mechanical pump (warming the solution to dispel dissolved gases) and then to about 5×10^{-5} mm. mercury by a backed mercury diffusion pump, nearly all the air can be removed prior to oxidation of ammonia by hypobromite. After the oxidation, the Rittenberg tube is attached to the mass spectrometer and immersed in liquid air to freeze out impurities. The gas is then expanded into a highly evacuated vessel of suitable volume (usually 50 ml.) for measurement of the peaks at mass numbers 28, 29, 30 and 32. In this way it is possible to obtain consistent measurements in samples containing as little as 30 μgm. nitrogen with very small or negligible corrections for contamination by air. Some typical examples of the estimates of nitrogen-15 abundance in amino-acids, separated chromatographically during the course of tracer experiments on yeast, are given in Table 1.

Table 1. Nitrogen-15 Abundance in Amino-Acids

Amino-acids	Nitrogen (μgm.)	Relative peak heights				Isotope abundance (atom per cent nitrog.n-15)	
		Mass 28	Mass 29	Mass 30	Mass 32	28 : 29	28 : 29 : 30
Aspartic acid	92	280	28·25	0·700	0·600	4·86	4·85
Threonine	49	100	17·75	0·825	0·215	8·24	8·25
Serine	29	150	19·0	0·630	0·125	5·98	6·00
Glutamine	91	347·5	66·6	3·26	0·340	8·76	8·78
Glycine	30	189	23·6	0·775	0·125	5·93	5·96

In samples of gas containing about 5 atom per cent nitrogen-15 or above, it is possible to calculate the abundance either from the ratio of mass numbers 28 : 29 or from the measurements of the three peaks 28, 29, 30 (Rittenberg[6]). Close agreement between the two estimates is obtained, thus indicating the validity of the small correction for contamination by air, based on the measurement of the peak for oxygen at mass 32.

With the precautions outlined above, measurements have been made over a period of several months on replicate samples containing 30 μgm. nitrogen of a standard solution of an enriched ammonium salt; fifteen measurements had a mean of 31·67 atom per cent nitrogen-15 with a standard deviation of ±0·17.

We are indebted to Mr. B. Davis for measurements on the mass spectrometer, which were carried out in the Department of Chemistry in the University.

The work was supported by research studentships awarded by the Agricultural Research Council.

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Mass-spectrometric Observations of Ions in Flames

As an extension of our studies of ionization in flames, previously based largely on conductivity measurements[1], an apparatus has been constructed for direct mass-spectrometric analysis of ions drawn from a flame. Whereas previously information about the nature and relative amounts of positive ions could only be obtained by inference from the electron concentration, it is now in principle possible to obtain directly the concentration of ions of any given mass number. It is the purpose of this communication to give preliminary qualitative results obtained with this apparatus, which prove to be of considerable interest.

In brief, the flame, burning at atmospheric pressure, is directed against a thin (0·002 in.) window in which

is a small hole of about 0·002 in. diameter, which samples about 1/4 c.c./sec. from the flame into a chamber, evacuated to $\sim 10^{-3}$ mm. by means of a fast pumping system. Using a series of ion lenses, it is found possible to direct a beam of ions into the slit of a conventional sector-type mass spectrometer, and thus to obtain a mass analysis. Ion concentrations down to 10^7 ions/c.c. in the flame are readily detectable.

So far, premixed hydrogen–air and acetylene–air flames have been studied (temperatures ~2,200° K.) and sprays of salts of the alkali and alkaline earth metals have been added, and the resulting ions investigated.

A feature common to all the simple ions found is an apparent facility of attachment of one or two, or even, to a small extent, three water molecules to the parent ion. It is not yet established whether these hydrated ions occur in the flames, or are formed at some stage of the sampling process, but the latter seems more probable.

In hydrogen flames with no additive, the main ion in the gases above the reaction zone appears to be H_3O^+, with a smaller peak corresponding to the attachment to this of a water molecule. There is also a fairly large peak at mass 18, which is thought to be due to H_4O^+. There are also traces of Na^+ and K^+, which seem to be inevitable, at least when using compressed air to run the flame.

On spraying salts of alkali metals into the flame, the expected peaks of the simple ions Li^+, Na^+, K^+, Cs^+ appear strongly, and also those of the hydrated ions, increasingly weaker as one, two and possibly three molecules of water are attached. On spraying a solution of strontium chloride into the flame, the ion peaks of Sr^+ appear, but somewhat stronger peaks appear seventeen mass numbers higher, which correlate with the ion $SrOH^+$, previously postulated by Sugden and Wheeler[2] on the basis of electron concentration measurements. A small peak at mass number 106 confirms the presence of some of the first hydrate of Sr^+, and likewise the second may be detected. Ion peaks corresponding to $SrOH^+nH_2O$ may be detected up to $n = 3$. Similar results are found with calcium and barium, except that Ba^+, if present, is below the limit of detection, and the hydroxide ion is predominant.

The flames of acetylene provide a more complicated system, and on sampling the primary reaction zone of an acetylene–air flame (near-stoichiometric mixture), ion peaks of varying sizes were found at almost every mass number up to 100. No analysis of this has yet been attempted. In the gases above the reaction zone, the ions are fewer both in number and in type. The peaks observed in hydrogen flames appear also in these, and the only additional prominent peak appears at mass number 30 (with its first hydrate at 48). The most likely formula for this is CH_2O^+ or NO^+. Further, it may be said, in the former case, that this is probably ionized formaldehyde rather than hydrated carbon, since no indication of the presence of C^+ was found. The appearance of this ion in the upper parts of the flame, and the disappearance of other ions just above the reaction zone, merit much further study.

It is our aim to extend this work as both a qualitative and quantitative study with various types of flame and metallic elements, and to publish details of the apparatus and further results in due course.

We wish to express our gratitude to the Research Laboratory of the General Electric Company of Schenectady, New York, for a grant in support of this work.

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Burning Voltage of Arcs in High Vacuum

In the course of an investigation of high-current arcs between solid electrodes in vacuum, an empirical relationship between arcing voltage and physical properties of the cathode material has been found. Certain exceptions are significant because, except for carbon, they are all ferromagnetic metals or alloys containing a ferromagnetic metal.

The burning voltage of an arc between two electrodes in vacuum is almost constant, increasing only very slightly with increase of current and depending in the main only on the nature of the cathode material. This applies provided that the anode subtends a large solid angle at the cathode, so that electrons and metal vapour ejected from the cathode spot or spots may follow line of sight paths to the anode. It is from the metal vapour ejected from the cathode spot or spots that the positive ions (which serve to neutralize the electronic space charge) are derived. The loss of positive ions from the discharge is small, so that the voltage gradient at any point in the discharge clear of the immediate neighbourhood of the cathode spot is negligible.

Although the arcing voltage of any particular metal is not steady, but contains high-frequency components, its average value is remarkably constant. The anode material does not normally affect the burning voltage, because the anode rapidly becomes coated with a thin film of material ejected from the cathode spot.

In Fig. 1, burning voltage is shown plotted against the product of boiling point and thermal conductivity of the cathode material. Normal temperature thermal conductivities have been used, because few data exist on thermal conductivities at elevated temperatures.

It is apparent that, with the exception of carbon and non-magnetic stainless steel, the arcing voltages of the non-ferromagnetic metals lie on or very near to a smooth curve, while the voltages of arcs on the ferromagnetic materials lie above the curve by an

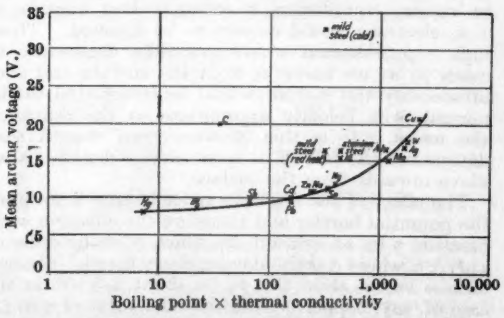

Fig. 1. Empirical relationship between arcing voltage in vacuum and physical properties for some common metals

amount that increases with the Curie point of the metal.

For steel the arcing voltage of 33 V. drops to 16·2 V. when the bulk of the metal is raised to a temperature at which it is a bright red, above the Curie point.

These results, which will be described fully elsewhere, give very considerable support to a new theory of electron emission from non-thermionic cathode spots, outlined in the following communication.

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The Arc Cathode

It is generally agreed that none of the theories that has been suggested gives a complete and convincing account of the mechanism of the non-thermionic arc cathode. Combinations of, say, thermal and field emission do not fare much better, particularly for cases like the mercury arc cathode[1]. What follows is a new approach which goes some way, if not all the way, towards a satisfactory theory.

In the pinch effect in a plasma the inward radial force is balanced by an increase in gas pressure which is, of course, unbalanced axially. The plasma maintains its state of electrical neutrality under the pinch forces. If, however, we consider what occurs in the metal, the fact that the positive charge centres—the crystal lattice points—are not free to move means that the pinch-effect forces are not balanced by an electron gas pressure but by space-charge forces: that is, the pinch effect sets up a negative space charge in the region of high current density near the cathode spot. The density of this space charge is easily shown to be:

$$\rho = \mu\varepsilon J\bar{v} \qquad (1)$$

where μ and ε have their usual meanings, J is the current density, and $\bar{v}$ is the mean velocity of the electrons carrying the current just inside the metal surface. But the electrons that can escape across the potential boundary must have energies greater than $W + \varphi$, where W is the Fermi energy and φ the work function, and so the appropriate value of $\bar{v}$ in equation (1) is of the order of

$$[(2/m)(W + \varphi)]^{1/2} \qquad (2)$$

Near the surface, therefore, the Fermi equilibrium is disturbed; there is a deficit of high p_z electrons, and to restore equilibrium a corresponding number of $-p_z$ electrons would require to be injected. These high $-p_z$ electrons would gradually degenerate to mean p_z as we move in from the surface and simultaneously the current would be transferred to the normal drift velocity appropriate to the centre of the metal. It is this 'slowing-down' length that determines the fall-off in space charge density as we move inwards from the surface.

The effect of the negative space charge is to lower the potential barrier and therefore the effective work function φ by an amount $\Delta\varphi$ which is of the order of $\mu\varepsilon J\bar{v}\Lambda^2\varepsilon$, where Λ is the slowing-down length. Characteristic values show this to be about 2–3 eV. in the case of, say, copper. Note that the value of φ in (2) must now be replaced by $\varphi - \Delta\varphi$. At high temperatures, where the simplified form of the Fermi distribution can be used, we then get an expression for the current density given by (Richardson formula):

$$J = AT^2\exp(-\varphi/kT)\exp(\Delta\varphi/kT)$$

where $\Delta\varphi$ is the solution of:

$$\Delta\varphi \sim \mu\varepsilon J\Lambda^2 e[(2/m)(W + \varphi - \Delta\varphi)]^{1/2} \qquad (4)$$

that is to say, (3) is an implicit equation for J.

The space charge produced by the pinch effect is thus responsible for lowering φ sufficiently to account for the electron emission.

This changes much of the usual picture. The current density in the metal produced in this way, together with the increased resistivity ($\propto p^2$) is responsible for the heating and evaporation of the metal at the cathode spot, which is therefore a purely secondary effect. The molten metal will itself have higher resistivity, and the depth of liquid below the surface is therefore involved. The result is that there is a considerable ohmic voltage drop *within* the metal. This has been pointed out by Reece (previous communication), who has shown, in the case of vacuum arcs, that the arc voltage is a function of the boiling point of the metal multiplied by the thermal conductivity of the metal and that a large part of the cathode fall is accounted for in this way. An unusual feature of the theory is the dependence on μ, which will have the effect of increasing the current density and therefore the cathode fall in the ferromagnetic metals. This is strikingly corroborated in Reece's experiments. Again, since there is always a parallel path of lower resistance through cold metal, the position of the arc is inherently unstable and hence must be in continual random movement.

Another consequence of this theory is that the time of disappearance of the cathode mechanism is just that of the dispersal of the electron space charge in the metal. It is in fact of exactly the same order as that observed for mercury arcs, namely, 10^{-9} sec.

There are several other consequences of the theory which, together with a more complete theoretical treatment and numerical verification, will shortly be published elsewhere.

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Preliminary Investigations of the Silicon Boride, SiB_6

Although there has been a good deal of experimental work on the borides of silicon dating back to Moissan[1], current reports (ref. 2 and Parthe, E., M.I.T., private communication) have been somewhat confusing as to the exact phases present in the boron–silicon system. We now wish to report that we have prepared single crystals of silicon boride (SiB_6) by fusion of the elements. The wet chemical analysis after removal of excess silicon agrees with stoichiometric values for the compound SiB_6 as are shown by the following determinations:

B—69·05, 70·16, 69·3
Si—29·43, 29·48, 30·4

The density as determined by pycnometer methods is 2·45 gm./c.c.

Preliminary investigations of the compound by Laue and rotation photographs have indicated an

orthorhombic unit cell with approximate lattice parameters of $a = 14{\cdot}60$ A., $b = 18{\cdot}40$ A., $c = 10{\cdot}02$ A. Based on the pycnometer density of 2·45 gm./c.c. the unit cell contains 42·7 molecules. These values confirm facial indices and axial ratios found from optical goniometer measurements. The structure appears to be quite complex, and further work using Weissenberg camera measurements will be necessary before an exact structure can be reported.

Electrical, hardness, and melting-point determinations indicate that the compound has interesting physical properties which are being investigated.

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Permeability and the Size Distribution of Pores

A RECENT communication by T. J. Marshall[1] directs attention to a formula for calculating the permeability of a porous medium from its pore-size distribution. This appears to be derived from an implicit model for a porous structure which is very similar to a model which we have found useful at the Gulf Laboratories. However, the formulæ which we derive are somewhat different from Dr. Marshall's.

The physical model, which we believe can be used advantageously to represent actual porous rocks, may be conceived in the following way. Consider a cylindrical bundle of straight capillary tubes the radii of which have a suitable range. Cut this bundle into thin slices, of equal thickness, perpendicular to its axis. Re-arrange randomly the pieces of tube in each slice and then reassemble the slices to form a cylindrical core. This structure of randomly interconnected capillary tubes of various radii forms the model which we have used for studying linear flow.

In any homogeneous porous body a plane section exposes a pore distribution the total area of which is a fraction φ of the area of the section, where φ is also equal to the volumetric measure of porosity. Hence, in any slice of the model the total area available for flow is φ times the area of the slice. Because of the random interconnexion between adjacent slices, however, the total area available for flow at the junctions is reduced to φ^2 times the area of a slice.

Based essentially on this idea, we have worked out formulæ relating capillary pressure, absolute and relative permeabilities, electrical resistivity index and formation factor. We have also set up a theory for the displacement of a fluid from a porous medium by a miscible fluid. Details will be published elsewhere.

It is noteworthy that the expressions we get for permeabilities are essentially the same as those derived empirically by Burdine[2]. A comparison with some of the available experimental work can be found in his paper. In view of the simplicity of the model, the general agreement between predicted and observed results is surprisingly good. It cannot be said, however, that an unequivocal conclusion has been reached.

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[1] Marshall, T. J., *Nature*, **180**, 664 (1957).
[2] Burdine, N. T., *Trans. Amer. Inst. Mech. Eng.*, **198**, 71 (1953).

FROM the preliminary information and the reference given by Dr. Wyllie and Dr. Gardner, it appears that the difference in their permeability equations may arise from their use of a term for tortuosity. I have avoided this mainly by allowing for the effect of imperfect fit and dead ends and the effect of the smaller pore in a sequence on the average size of the necks connecting the pores. Further details are given in a paper[1] which is to appear shortly.

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Effect of Plastic Deformation on the Electrical Resistivity of Chromium

THE presence of a transition in the electrical resistivity and temperature coefficient of resistance of chromium in the region of 40° C. has been reported by several investigators[1]. In studying the influence of plastic deformation (at 150° C.) on high-purity chromium an anomaly has been found, in that below the transition temperature the deformed material had a lower resistivity than the annealed. Curves of resistivity versus temperature are shown in Fig. 1, together with the respective temperature coefficients of resistance. No hysteresis was observed in these measurements. A positive deviation in the temperature coefficient of resistance of the deformed material is observed both below and above the transition temperature. A minimum in the curve of resistivity versus temperature for the annealed material (Fig. 1) occurs at 41° C. and is in close agreement with other workers. Particulars of the specimen material are recorded in Table 1. As shown in Fig. 2, a change in the sign occurs, from negative to positive, in the value of $\Delta\rho$ (the difference in resistivity between the deformed and the annealed material) on increasing temperature through the transition region, namely, $-40°$ C. to $+40°$ C.

Table 1. RELEVANT HISTORY OF THE SPECIMEN

Analysis of chromium* (per cent)		Analysis of chromium* (per cent)	
Mg	< 0·0002	Ag	0·0001
Pb	0·0002	Tl	trace
Si	< 0·0005	C	< 0·0015
Al	0·0005	O_2	< 0·013
Fe	< 0·0005	N	< 0·0005
Cu	0·0002	H_2	< 3·0 ml./100 gm.

* All metallic elements determined spectrographically. (*a*) Specimen dimensions: 0·027 in. (0·073 cm.) diameter, 8·8 in. (20·7 cm.) length. (*b*) Specimen history: arc melted electrolytic chromium ingot (1·5 in. diameter) → extruded bar (0·5 in. diameter) → swaged rod (0·2 in.) diameter) → wire drawn to 0·027 in. diameter at 300° C. final 3 per cent reduction at 150° C. Total reduction in area 98 per cent. (*c*) Annealing treatment: 700° C. for 15 min. *in vacuo* (2×10^{-4} mm. of mercury); specimen completely recrystallized after this treatment.

Previous investigators[2] have reported changes in other physical properties of chromium in this temperature region although no satisfactory explanation for this transition has so far been given. It has been suggested[3,4] that the transition may be associated with a magnetic change at about 40° C. in residual chromic oxide (Cr_2O_3).

From the generally similar shape of the curves of temperature versus resistance for specimens annealed or plastically deformed, it seems reasonable to assume that the factors influencing the transition are similar in both states. Above the transition temperature the normal increased resistance in deformed material is observed; this is due to the scattering of conduction electrons by the lattice defects introduced during the deformation process. However, below the transition temperature, after deformation a modification must occur to that part of the resistance dependent on temperature, which in this particular case more than compensates for the scattering produced by lattice defects and leads to an overall decrease in the resistance relative to the annealed material. This modification is manifested as a 5 per cent decrease in resistivity on superimposing the positive value of $\Delta\rho$ at 70° C., on the $\Delta\rho$ value at −60° C. (Fig. 2) and suggests a deviation from the normal electronic structure for chromium below the transition temperature, the normal structure being taken as that state which is essentially consistent with Matthiessen's rule.

Both Thomas[5] and Linde[6] have reported a decrease in resistivity in gold/chromium alloys with cold work and Linde[7] has postulated a change in the dynamic

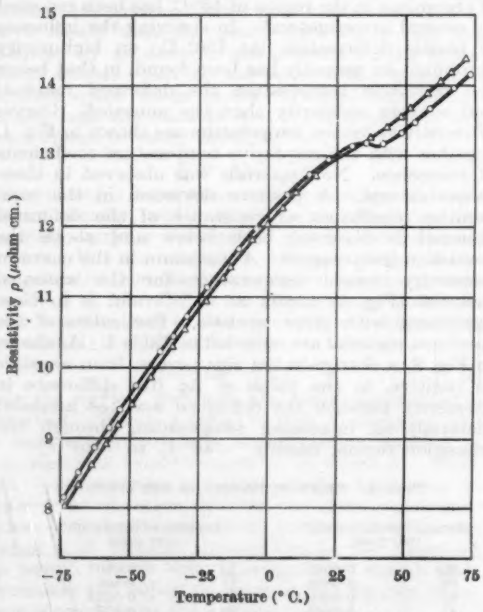

Fig. 1. Resistivity of annealed (○) and deformed (△) chromium as a function of temperature

Temperature range (° C.)	Temperature coefficient of resistance × 10^2	
	Annealed	Deformed
− 70 to − 45	7·16	7·40
45 to 70	2·50	2·58

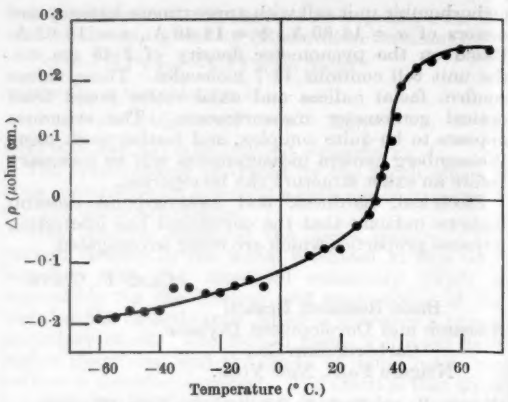

Fig. 2. Variation of $\Delta\rho$ with temperature

equilibrium between the electrons in the 3*d*- and 4*s*-shells in certain chromium atoms after cold work. The net result of this exchange is a reduction in the capture of conduction electrons by the *d*-shells by virtue of the more stable electron configuration attained by certain atoms, probably those displaced most from their lattice positions. This explanation has been supported by magnetic measurements on cold worked alloys of gold and chromium[8] which have shown a change in magnetic susceptibility corresponding to an increase in the number of electrons bound to the 3*d*-shell.

Electrolytic chromium is characterized by an increase in magnetic susceptibility with increasing temperature[3,9]. No irregularities have been observed in the susceptibility near the transition region. An antiferromagnetic superlattice has been detected by neutron diffraction experiments[10] at very low temperature with a Néel temperature of 200° C. Unfortunately no magnetic measurements are available for chromium in the worked condition to check the Linde hypothesis with respect to very pure chromium. It would seem, however, that the fundamental reason underlying the decrease in resistance is the abnormal electronic state present below the transition temperature and that the effect of deformation will not be fully understood until this state is defined and the reason for the transition determined.

A detailed report on the resistance measurements of chromium will be published elsewhere. Acknowledgment is made to Mr. J. I. Nish for his encouragement throughout this work and to the Chief Scientist, Department of Supply, Australia, for permission to publish it.

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Oxygen-cutting of Vanadium

THE mechanism controlling the oxygen-cutting of iron and steel has been investigated by this Association, primarily along the lines of previous work by Wells[1], whereby attention was focused on the iron/oxygen combustion process. Recently this work has been extended to the study of the general conditions governing the progress of flame cuts through elementary materials, propagated by combustion with a pure gaseous element. The situation has been analysed in some detail for oxygen and chlorine. With the halogen gases, melting points of the elements most likely to be cut appear to be below the ignition temperature in the gas; no cuts were obtained in the cases of zinc and magnesium, which were otherwise thought to be likely to respond. Other halogen gases have not been tested experimentally, though it is known that fluorine may be used for flame-cutting copper[2].

In the field of oxygen-cutting, probable natural flame-cutting elements are iron, titanium, vanadium and antimony. Experimentally, the latter element does not ignite below its melting point, but the first three are readily cut. Iron and steel cutting by oxyacetylene, hydrogen, propane, coal-gas or oxy-arc processes, has, of course, been in use for many years. Flame-cutting of titanium by the oxyacetylene process has formed the subject of a detailed report[3], as it was not realized that the process was known in the United States[4], though investigations by this Association were conducted independently.

Vanadium was selected as a trial element, since no previous tests were known, and, owing to the high cost of the material and its scarcity in massive form, it would be unlikely to be attempted outside a research laboratory. Because of the extremely poisonous nature of the vanadium oxides, it is necessary to conduct the cutting operation in a closed chamber, progress being viewed through a glass window. Two successful cuts have been made in a vanadium plate 11 cm. × 5 cm. × 0·6 cm. obtained through the courtesy of the United Kingdom Atomic Energy Authority. The first cut was made manually and the second with a motor-driven oxyacetylene torch at 32 in./min. traverse speed. The surfaces near the pre-heat initiation point were contaminated with condensed vanadium metal and oxide, but away from the pre-heat area contamination was limited to a temper-coloured zone about $\frac{1}{8}$ in. on either side of the cut edge. There was no appreciable hardening on the surface of the plate to within $\frac{1}{16}$ in. of the cut. As in titanium, the major deleterious effect would be expected to be oxygen pick-up by the edge. Owing to the high reactivity of vanadium, its flame-cutting properties would be expected to be more akin to titanium than to mild steel.

Apart from confirming previous conceptions of the process, the successful test on vanadium makes it likely that alloys of the iron–titanium–vanadium system would be 'cuttable' by oxygen methods.

A more detailed account of this work will appear elsewhere.

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Structure of Cupric Salts with Mono-, Di- and Tri-chloroacetic Acids

IN former communications[1], we reported that the cupric salts, anhydrous or hydrated, with *n*- and *iso*-monocarboxylic acids might consist of the dimeric molecules having a sort of copper-to-copper linkage. In continuation of these researches, we have recently examined the structure of cupric salts with mono-, di- and tri-chloroacetic acids, using the criteria previously derived: (1) the cupric alkanoates involving the dimeric molecules show, in addition to a band at about 43×10^{13} c./s., an absorption band of a special kind at about 80×10^{13} c./s., which was regarded as due possibly to the presence of the copper-to-copper linkage; (2) the polarization of the latter band is the reverse of the polarization of the former.

The present measurements indicate that cupric monochloroacetate and dichloroacetate in dioxane show absorption spectra which are closely similar to those of the cupric alkanoates in solution, showing an absorption band of the special kind at about 80×10^{13} c./s. The dichroism in the visible and ultra-violet of the two compounds has been determined quantitatively by Tsuchida–Kobayashi's microscopic method[2]. The crystals of cupric monochloroacetate tetrahydrate and anhydrate, and of anhydrous cupric dichloroacetate all show absorption bands at about 41 and 80×10^{13} c./s. besides strong absorption in the shorter wave-length regions. The polarization of the band at about 80×10^{13} c./s. is found to be the reverse of the polarization of the band at about 41×10^{13} c./s. These relationships bear a close resemblance to those with the cupric alkanoates, suggesting the existence of dimeric molecules similar to those of the alkanoates. Thus it may be concluded that cupric monochloroacetate and dichloroacetate have the dimeric molecules in dioxane and in the crystalline state. The dimeric molecules may be represented by $Cu(R.COO)_4$ or $Cu(R.COO)_4.(OH_2)_2$.

In contrast to the above mentioned compounds, cupric trichloroacetate in dioxane shows only one absorption band at about 40×10^{13} c./s. in the corresponding wave-length range. Furthermore, cupric trichloroacetate tetrahydrate in the crystalline state displays polarized absorption spectra having only the absorption band at about 40×10^{13} c./s. Thus the spectra of the compound are found to be quite different from those of the other two compounds. It is concluded, therefore, that the trichloroacetate does not involve the dimeric molecules in the crystalline state or in dioxane.

Cupric dichloroacetate is known to exist in a tetrahydrate as well. The dichroism of this form is not quite identical with that of the anhydrous form, which is shown to consist of the dimeric molecules. The structure of the tetrahydrate in the crystalline state is under investigation.

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Time Variation of Chemical Affinity

In two previous communications[1,2] we have shown that an accelerated chemical reaction is always characterized by the variation of the chemical affinity of the system with time. For a reaction with constant velocity this time derivative would, of course, be zero. In this communication we shall consider further the properties of the function $\dot{A} \equiv (\mathrm{d}A/\mathrm{d}t)$. A is the instantaneous chemical affinity defined by

$$A = -\sum_i \nu_i \mu_i \qquad (1)$$

In this equation, ν_i is the stoichiometric coefficient, and μ_i is the instantaneous chemical potential of the ith component. Since this potential is a function of the activity of the particular substance, it will vary with concentration, and hence with time. Bearing this in mind, we can now differentiate equation (1) with respect to time :

$$\dot{A} = -\sum_i \nu_i \dot{\mu}_i \qquad (2)$$

Throughout this discussion the pressure and temperature will be assumed constant.

Utilizing the definition of μ_i in terms of the activity coefficient[3]

$$\mu_i = \mu_i^0 + RT \ln a_i$$

where a_i is the activity of the component i and μ_i^0 is the chemical potential of this substance in the arbitrary standard state, we obtain

$$\dot{\mu}_i = RT\, \mathrm{d}/\mathrm{d}t(\ln a_i)$$

By substitution in equation (2) we have

$$\dot{A} = -RT \sum_i \nu_i\, \mathrm{d}/\mathrm{d}t(\ln a_i) \qquad (3)$$

This equation can alternatively be established from the relation[3] between the affinity and the equilibrium constant K :

$$A = RT \ln K - RT \ln \prod_i a_i^{\nu_i}$$

Differentiating this relation with respect to time, we get

$$\begin{aligned} \dot{A} &= -RT\, \mathrm{d}/\mathrm{d}t\, (\ln \textstyle\prod_i a_i^{\nu_i}) \\ &= -RT\, \mathrm{d}/\mathrm{d}t(\textstyle\sum_i \nu_i \ln a_i) \\ &= -RT \textstyle\sum_i \nu_i\, \mathrm{d}/\mathrm{d}t(\ln a_i) \qquad (3a) \end{aligned}$$

If the behaviour of the substances participating in the reaction tends to ideality, we may replace activities by concentrations (that is, the activity coefficient can be regarded as unity for our purposes). Thus,

$$\dot{A} = -RT \sum_i \nu_i\, \mathrm{d}/\mathrm{d}t(\ln c_i)$$

where c_i is the concentration of the ith component at any instant. As an approximation, therefore, we arrive at $\dot{A}$ from the experimental observation of the change of $(\ln c_i)$ with time. We should note, of course, that the rate of change of concentration with time is related to the reaction velocity, but in the case of the accelerated reaction under consideration the velocity has different values with successive instants of time.

For the sake of completeness we can show how the acceleration of a chemical reaction may be related to the time variation of the chemical affinity.

We can define the acceleration and velocity of a chemical reaction by

$$v = \mathrm{d}\xi/\mathrm{d}t \text{ and } \dot{v} = \mathrm{d}^2\xi/\mathrm{d}t^2$$

where $\mathrm{d}\xi = \mathrm{d}n_i/\nu_i$ (n_i is the mole number of the ith component). Previously[1] we formulated the relation

$$\dot{v} = (\dot{A}/A)v$$

which, in terms of equation (3), becomes

$$\begin{aligned} \dot{v} &= \frac{-RT \sum_i \nu_i\, \mathrm{d}/\mathrm{d}t(\ln a_i)}{RT \ln K - RT \ln (\prod_i a_i^{\nu_i})} v \\ &= \frac{-\sum_i \nu_i\, \mathrm{d}/\mathrm{d}t(\ln a_i)}{\ln K - \ln(\prod_i a_i^{\nu_i})}\, v \end{aligned}$$

or approximately,

$$\dot{v} = \frac{-\sum_i \nu_i\, \mathrm{d}/\mathrm{d}t(\ln c_i)}{\ln K - \ln(\prod_i c_i^{\nu_i})}\, v \qquad (4)$$

However, from the experimental point of view it is much simpler to obtain the acceleration directly from the definition

$$\dot{v} = \frac{\mathrm{d}^2\xi}{\mathrm{d}t^2} = \frac{1}{\nu_i}\frac{\mathrm{d}^2 n_i}{\mathrm{d}t^2} = \frac{1}{\nu_i}\frac{\mathrm{d}^2(Vc_i)}{\mathrm{d}t^2} \qquad (5)$$

where V is the volume. Equation (5) implies that data for only one reactant are required to compute the acceleration. Equation (4) can thus claim no heuristic value, but is relevant to our discussion as a merely theoretical deduction.

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Complex Formation between Groundnut Skin Pigments and Conarachin II

When defatted groundnut meal containing a portion of the red skins of the nut was extracted with 10 per cent (w/v) sodium chloride solution and the extract dialysed against phosphate–sodium chloride buffer, ionic strength I 0·5, pH 8, the sedimentation-velocity diagram (Fig. 1*a*) revealed the presence of three components : arachin, the major component (sedimentation constant, $s^\circ_{20} = 13{\cdot}3$ S., conarachin II ($s^\circ_{20} = 8{\cdot}4$ S.) and conarachin I ($s^\circ_{20} \approx 2$ S.)[1]. When the extraction was carried out at pH 8–9 with sodium hydroxide, the solution was considerably more red in colour, the conarachin II component was less apparent, and the presence of a fourth, very fast sedimenting component ($s^\circ_{20} = 32$ S.) was observed (Fig. 1*b*). This fast component was absent, however, in extracts of blanched nuts or white skinned nuts. It would therefore appear to be connected with the presence of the red skin pigments in the meal.

The addition of calcium chloride (4 gm./l.) was found to precipitate most of the protein from a pH 8–9 extraction liquor leaving the colour in the supernatant liquor. When the latter was saturated with ammonium sulphate, the remaining protein precipitated along with the red pigment leaving an

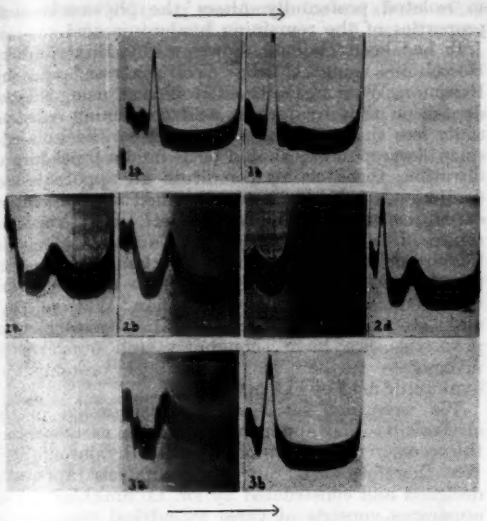

Fig. 1. Sedimentation diagram of: *a*, 10 per cent sodium chloride extract; *b*, (*p*H 8)-extract of groundnut meal containing some of the red skins. Both extracts dialysed to *I* 0·5, *p*H 8. Protein concentration, 1 gm./100 ml.

Fig. 2. Sedimentation diagrams in (*I* 0·5, *p*H 8)-buffer of: *a*, protein in supernatant of a (*p*H 8)-extract of groundnut meal after addition of calcium chloride: (4 gm./l.); *b*, 65/85 ammonium sulphate fraction of the supernatant; *c*, sediment after solution-*b* was spun in ultracentrifuge at 150,000*g* for 3 hr.; *d*, protein left in supernatant after (*p*H 8)-extract of meal was saturated to 65 per cent with ammonium sulphate. Protein concentration, 1 gm./100 ml.

Fig. 3. Sedimentation diagrams of: *a*, conarachin II (*I* 0·5, *p*H 8) + dark coloured (*p*H 9)-extract of red skins of the groundnut; *b*, conarachin II at *I* 0·5, *p*H 8

almost colourless supernatant. The precipitate in (*I* 0·5, *p*H 8)-buffer gave a dark red solution and the sedimentation diagram of Fig. 2*a*. If the supernatant, after the calcium chloride precipitation, was first 65 per cent saturated with ammonium sulphate, the protein which precipitated was not coloured. Further saturation from 65 to 100 per cent with ammonium sulphate produced a dark precipitate, giving in (*I* 0·5, *p*H 8)-buffer the sedimentation diagram of Fig. 2*b*. This diagram shows the presence of a higher proportion of the s_{32} component. The solution giving Fig. 2*b* was then centrifuged at 40,000 r.p.m. (150,000*g*) in the preparative head of the 'Spinco' Model *E* ultracentrifuge for 3 hr., and the sediment, when dissolved in (*I* 0·5, *p*H 8)-buffer, gave an extremely dark coloured solution and the sedimentation diagram of Fig. 2*c*. It will be observed that the proportion of s_{32}-component in this diagram is greater than that in Fig. 2*b*. This fast component was also observed in the supernatant after an extract of *p*H 8–9 of groundnut meal was 65 per cent saturated with ammonium sulphate (Fig. 2*d*). Its presence was only observed in highly coloured solutions.

When the solution giving Fig. 2*c* was dialysed against buffers at *I* 0·5 in the *p*H range 5–11 no change in the sedimentation diagram was observed. The addition of 5 *M* urea caused no change in the sedimentation diagram. When, however, the solution giving Fig. 2*c* was extracted with methyl ethyl ketone, a known solvent for vegetable tannins[2], the colour was removed from the solution, and the s_{32}-component was replaced by a component of sedimentation constant close to that of conarachin II. It thus appeared that the s_{32}-component was a complex between conarachin II and the groundnut skin pigments.

In order to confirm this, it was decided to attempt a synthesis of the complex from the protein and the pigments. The red skins of groundnuts were extracted at *p*H 9 with sodium hydroxide. Some of the very dark extract was then added to each of the three groundnut–protein fractions, arachin, conarachin I and conarachin II dissolved in (*I* 0·5, *p*H 8)-buffer. With arachin and conarachin I orange precipitates were formed. With conarachin II, however, no precipitation occurred, and the solution in the ultracentrifuge gave the sedimentation–velocity diagram of Fig. 3*a*, which shows the presence of a fast sedimenting component ($s^\circ_{20} \approx 32$ S.) but more polydisperse than the s_{32} component of Fig. 2. The diagram for conarachin II itself is shown in Fig. 3*b*.

The presence of four pigments in groundnut testa (tannin, phlobaphene, leuco-anthocyanin and flavone) has been reported[3]. Since the red tannin is the water-soluble pigment it seems probable that the complex is formed between conarachin II and the tannin. In view of the considerable increase in the sedimentation constant of conarachin II (8·4 → 32 S.) it would appear that some cross-linking of the protein by the tannin occurs to form the complex.

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Isolation of 2-Nitro-phenol from the Mixture of Mono-nitro-phenols

2-Nitro-phenol is usually prepared from the mixture of mono-nitro-phenols obtained by nitration of phenol. According to the classical methods[1] the isomers can be separated by steam distillation, as the steam volatility of the 2-nitro product is higher than that of the 3-nitro- or 4-nitro-phenol. The 2-nitro-phenol obtained by these methods, however, is usually contaminated by more or less of the 3-nitro- and 4-nitro-isomers. A number of interesting publications have appeared on the preparation of the pure products[2].

A convenient method of isolating practically pure 2-nitro-phenol has been devised, which may be used for avoiding the adoption of the steam distillation in certain cases, and is also suitable for further purification of the steam distillate. Apart from its use in the laboratory, the procedure has potential industrial application in working up mixtures of nitro-phenols obtained either by nitration of phenol or by hydrolysis of nitro-chloro-benzenes.

The method is based on the different solubilities of the sodium salts of mono-nitro-phenols in dry ethanol. As the sodium salt of 2-nitro-phenol[3] has the lowest solubility among them, it can be separated from an adequately concentrated alcoholic solution of mono-nitro-phenols by adding sodium ethylate. Having a mixture of sodium salts of the nitro-phenols, the sodium 3-nitro-phenoxide and 4-nitro-phenoxide can be dissolved with a suitable quantity of dry

ethanol, while the sodium salt of the 2-nitro-phenol remains undissolved. In choosing the appropriate quantity of the solvent it must be taken into consideration that 3·9–4·0 gm. of sodium 4-nitro-phenoxide and 0·4–0·5 gm. of sodium 2-nitro-phenoxide, respectively, can be dissolved in 100 ml. of dry ethanol at 20° C.

Isolation of 2-nitro-phenol from the solution of mono-nitro-phenols. 2·5 gm. of 4-nitro-phenol and 7·5 gm. of 2-nitro-phenol (melting point, 43·5–44·5° C.) are dissolved in 45 ml. of dry ethanol, then 27 ml. of a solution of sodium ethylate (1·35 gm. of sodium metal dissolved in 27 ml. of dry ethanol) is added, and allowed to stand for an hour at room temperature. The sodium salt of 4-nitro-phenol remains dissolved, while the red-coloured sodium salt of 2-nitro-phenol separates. After filtration it is washed successively three times with 20 ml. and once with 7 ml. of dry ethanol cooled in ice, finally with two 15-ml. portions of benzene, and dried at 105° C. The sodium-2-nitro-phenoxide thus obtained (7·6 gm., 87 per cent yield) is converted into the phenol by treatment with 28 ml. of 5 *N* sulphuric acid on a steam-bath, and then allowed to stand overnight in a refrigerator. The crystallized 2-nitro-phenol is filtered, crushed and rubbed with ice-cooled water in a mortar, filtered again, rewashed with ice-cooled water, and dried at room temperature (6·4 gm., 85 per cent yield. Melting point, 43·5–44·5° C.).

Isolation of 2-nitro-phenol from the mixture of the sodium salts of mono-nitro-phenols. 4·95 gm. of sodium-4-nitro-phenoxide and 10·05 gm. of sodium-2-nitro-phenoxide are dissolved in water, and the solvent evaporated. The dry residual mixture of the sodium salts is extracted with 150 ml. of dry ethanol, stirring for 40 min. at 70° C. It is then cooled to room temperature; filtered, washed successively five times with 20 ml. of ice-cooled dry ethanol and three times with 20 ml. of benzene, and finally with two 10-ml. portions of ethanol. The sodium salt of 2-nitro-phenol dried at 105° C. weighs 8·0 gm. (80 per cent yield). The salt is converted into 2-nitro-phenol by acidification as above. (Melting point, 43·5–45·0° C.)

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Electrophoretic Removal of Protein from Hyaluronic Acid

Evidence has been presented[1–3] to show that the hyaluronic acid of ox synovial fluid exists as a complex with a specific protein[4], the latter constituting 25–30 per cent of the total complex. This evidence is, in brief, that hyaluronic acid isolated from synovial fluid by a sufficiently mild means (differential filtration) cannot be obtained free from this amount of protein, and that removal of the protein (as by proteolytic action) from the material so isolated profoundly alters the physicochemical properties of the remaining hyaluronic acid.

It has been claimed, however, by Blix[5] and by Hesselvik[6] using U-tube electrophoresis and by Roseman, Watson, Duft and Robinson[7] using electrodeposition that hyaluronic acid containing substantially less than 25 per cent protein can be isolated; since electrophoresis should be as mild a procedure as filtration, these claims constitute an apparent contradiction of the evidence obtained from filtration experiments. Ogston and Stanier[8], in attempts to repeat Blix's procedure, were unable to obtain hyaluronic acid containing less than 25 per cent protein. Although it has not yet been shown that the products obtained by Roseman, Watson, Duft and Robinson have unchanged physicochemical properties, we have thought it well ourselves to investigate further the removal of protein from hyaluronic acid by electrophoresis.

We were not satisfied that the design of the electrodeposition apparatus[8] was such as to prevent the access of electrode products to the hyaluronic acid. We therefore used an electrodialysis apparatus designed and constructed by Dr. O. Smithies[9]. This apparatus consists of three cylindrical chambers of diameter 3 cm. The end-chambers contain circular platinum electrodes of large area, and the transfer of electrode products to the central compartment (10 ml. capacity) is entirely prevented by a carefully directed flow of fresh buffer through the electrode compartments. The maximum current employed in the apparatus was 40 m.amp., about 5·6 m.amp./cm.^{2}. 'Millipore' (Millipore Filter Corporation, Watertown, Mass.) *HA* membranes of pore diameter 0·4μ were used for separating the central compartment from the electrode chambers. The buffer used was 0·025 *M* phosphate, *p*H 7·0. The entire apparatus was used in the cold room at about 2° C.

Preliminary experiments indicated that the 'Millipore' membranes do not permit hyaluronic acid from ox synovial fluid to pass, even under considerable pressure, but do allow the passage of protein. Albumin and γ-globulin were found to migrate freely out of the central compartment with the application of an electric current.

Electrodialysis of ox synovial fluid at about 37 m.amp. caused a rapid loss of protein through the membranes. Colour was almost completely gone at the end of 11 hr. At 14 hr. ultra-violet absorption measurements revealed about 66 mgm. of protein per 100 ml.; at 18 hr., 38 mgm.; and at 22 hr., 23 mgm. At 26 hr. and 30 hr., however, the protein remained at 23 mgm./100 ml. This and another sample of ox synovial fluid, electrodialysed for 36 hr. at 37 m.amp., showed protein contents of 30 per cent of the hyaluronic acid complex.

To confirm this finding, a sample of hyaluronic acid complex prepared by filtration and containing initially 30 per cent protein was electrodialysed for 12 hr. at 37 m.amp. This period was sufficient to remove about 90 per cent of the total protein from synovial fluid, and assuming an exponential loss of protein, approximately the same proportion should have been removed from this material. At the end of the 12 hr., however, the protein content was unaltered. The viscosity and the non-Newtonian variation of viscosity with velocity gradient also remained unchanged.

Since there is reason to think that the protein present in the complex is of normal molecular size[4], and hence that it would, if free, be readily removed

through the 'Millipore' membrane (as are all the other proteins of ox synovial fluid, as well as the two serum proteins tested), this evidence suggests that this protein cannot be removed from the complex by simple electrophoresis. Its removal by electrodeposition may have been the result of oxidation or change of *p*H caused by electrode products.

We are grateful to Dr. S. Roseman for unpublished information.

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Dextrorotatory Urobilin-IXα and Racemic *d*-Urobilin

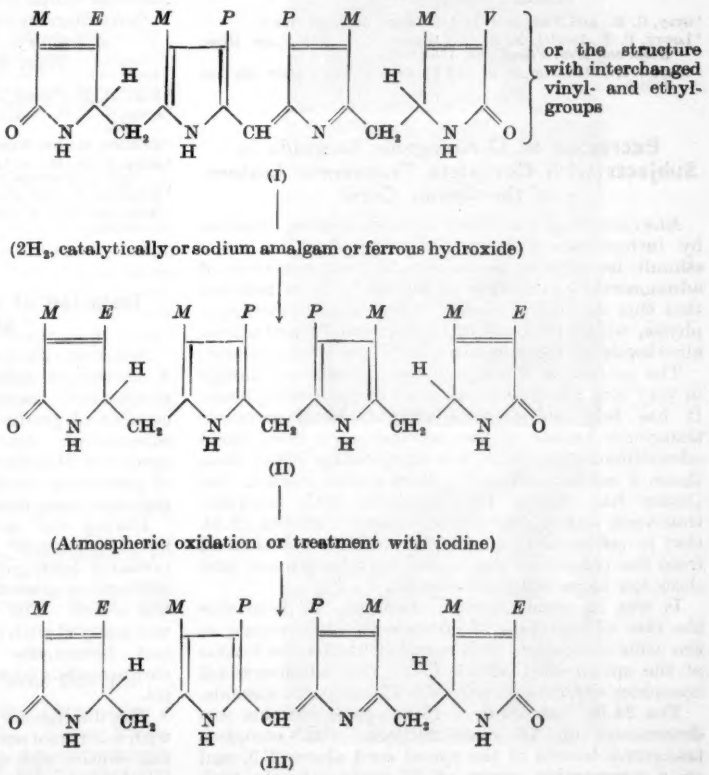
Of the three hitherto known bilene-*b* pigments only *l*-stercobilin and *d*-urobilin are optically active; *i*-urobilin has never been obtained in an optically active form. We now report the isolation of a dextrorotatory urobilin IXα and a racemic form of *d*-urobilin.

d-Urobilin appears to be formally derived from *i*-urobilin by replacement of an ethyl group by a vinyl group[1]. This is in agreement with Watson's earlier observation[2] that sodium amalgam or ferrous hydroxide reduction of *d*-urobilin gives a mesobilirubinogen (II) evidently identical with the compound obtained by total reduction of bilirubin since both afford *i*-urobilin (III) on oxidation. In the presence of colloidal platinum, *d*-urobilin hydrochloride ($[\alpha]_D^{CHCl_3}$ = +4,390) in methanol or acetic acid absorbs a maximum quantity of two molecular proportions of hydrogen. However, the leuco-compound thus produced differs from the mesobilirubinogen obtained in Watson's experiments in providing, on oxidation, not *i*-urobilin but a dextrorotatory urobilin of $[\alpha]_D^{CHCl_3}$ = about + 4,950. Quantitative hydrogenation of this pigment shows the presence of only one reducible double bond per molecule (as in *i*-urobilin) and not two (as in *d*-urobilin).

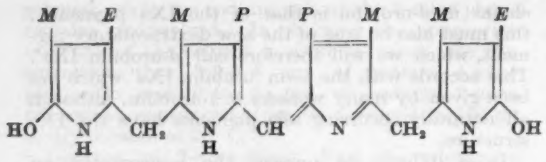
If the structure of *d*-urobilin is that shown in I the new dextrorotatory pigment can only be an optically active isomer of *i*-urobilin. We have recently shown[3] that the order of the β side-chains in *d*-urobilin is that of the IXα pigments; this must also be true of the new dextrorotatory pigment, which we will therefore call '*d*-urobilin IXα'. This accords with the term 'urobilin IXα' which has been given by many workers to *i*-urobilin, although all naturally occurring bile pigments have the IXα structure.

It is difficult to prevent the isomerization of *d*-urobilin to other pigments when the substance is in alkaline solution; but treatment, under hydrogen, with 1·25 *N* sodium hydroxide at laboratory temperature, causes complete racemization in 45 min., about 60 per cent of the pigment remaining as a urobilin. It has been possible to isolate sufficient of the crystalline, racemic urobilin hydrochloride for quantitative hydrogenation; the compound resembles *d*-urobilin but differs from *i*-urobilin in containing two reducible double bonds per molecule.

The existence of an optically active urobilin IXα is of some significance in relation to the structure of the end rings in such pigments. The classical hydroxypyrrole formulæ for *i*-urobilin (IV) and other bile pigments imply the absence of any element of asymmetry apart from that conferred by the asymmetric IXα order of the β side-chains; the substances would not, therefore, be expected to show any significant optical activity. On the other hand, structure III contains two asymmetric carbon atoms so that this structure is more in keeping with the observed optical activity of *d*-urobilin IXα. Doubtless the conditions prevailing in amalgam- or alkaline


M E M P P M M V
or the structure with interchanged vinyl- and ethyl-groups
(I)
(2H, catalytically or sodium amalgam or ferrous hydroxide)
(II)
(Atmospheric oxidation or treatment with iodine)
(III)

where $M = CH_3$; $E = C_2H_5$; $P = CH_2CH_2CO_2H$; $V = CH_2{=}CH{-}$



(IV)

ferrous hydroxide reduction of *d*-urobilin are suitable for the racemization of the pigment, and this would explain the formation of *i*-urobilin in Watson's experiments.

d-Urobilin IXα also undergoes racemization in alkali. It is possible that *i*-urobilin, prepared from mesobilirubinogen formed by amalgam reduction of bilirubin, is a true meso compound, but the racemized pigment must contain equal quantities of enantiomorphs. It should therefore be possible to obtain, in addition to the above pigments, a lævorotatory urobilin IXα which is not identical with stercobilin as well as an *l*-dehydro-urobilin IXα which is enantiomorphous with *d*-urobilin.

The quantitative hydrogenations were kindly carried out by Miss J. Cuckney, of the Micro-analytical Department of the Imperial College of Science and Technology.

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Excretion of 17-Ketogenic Steroids in Subjects with Complete Transverse Lesions of the Spinal Cord

Elevation of the blood adrenaline-level, whether by intravenous infusion or in response to stress stimuli, leads to an increase in the concentration of adrenocortical hormones in blood[1–4]. It is believed that this increase is mediated by the anterior hypophysis, which responds to the increased blood adrenaline levels by releasing adrenocorticotrophic hormone.

The peripheral blood contains adrenaline, though in very low concentrations, even in the resting state. It has been shown that subjects with complete transverse lesions of the cervical cord have blood adrenaline-levels which are significantly lower than those of normal subjects[5]. More recent work in this Centre has shown that subjects with complete transverse lesions above fifth thoracic vertebra (*T*.5), that is, subjects whose adrenal medullæ are isolated from the control of the higher nervous centres, also show low blood adrenaline-levels.

It was of some interest, therefore, to determine the rate of excretion of adrenocortical hormones in the urine of subjects with complete transverse lesions of the spinal cord above *T*.5. The adrenocortical hormones determined were the 17-ketogenic steroids.

The 24-hr. excretion of 17-ketogenic steroids was determined on 16 male subjects with complete transverse lesions of the spinal cord above *T*.5, and on a comparable group of 17 male subjects with transverse spinal cord lesions complete below *T*.5.

The results are summarized in Table 1.

Table 1. 24-hr. 17-Ketogenic Steroid Excretions

Subjects	No. of determinations	Mgm. 17-ketogenic steroids excreted/day (mean ± *S.D.*)
Normals (from Norymberski *et al.* (ref. 6))	8	13·15 ± 3·48
Subjects with lesions below *T*.5	17	14·0 ± 3·19
Subjects with lesions above *T*.5	16	5·8 ± 2·26

For the purpose of statistical analysis, the results of excretion of 17-ketogenic steroids by normal men obtained by Norymberski *et al.*[6] have been used. The results obtained from subjects with lesions complete above *T*.5 are significantly lower ($P < 0{\cdot}01$) than results from subjects with lesions complete below *T*.5 and than from results from normal subjects; there is no significant difference between the results from normal subjects and those from subjects with lesions below *T*.5.

The results are in harmony with the view that adrenaline is concerned in the release of adrenocortical steroids not only in stress conditions but also under resting conditions.

Studies are at present in progress on the plasma 17α-hydroxycorticosterone-levels in subjects with spinal cord lesions. The results of these studies, together with those reported above, will be published *in extenso* at a later date.

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Isolation of a New Flavin produced by an Actinomycete

Since the discovery that riboflavin is produced by *Eremothecium ashbyii* and *Ashbya gossypii*[1], a great number of bacteria and fungi have been found capable of producing this and other closely related substances[2]. Among the *Actinomycetales* only a few species of *Mycobacterium*[3] have been reported capable of producing riboflavin, while no true Actinomycete has ever been found to possess such a capacity.

During the isolation of an antibiotic produced by *Streptomyces* 476, a still unidentified species probably belonging to the *griseus* group, a considerable yellow-green fluorescence of the metabolic liquids was noted. The riboflavin potency of such liquids was assayed with mutant strains of *Lactobacillus casei* and *Leuconostoc mesenteroids*, giving an activity corresponding to a riboflavin content of 0·9–1·2 μgm./ml.

The fluorescent pigments could be easily extracted with *n*-butanol and purified by absorption on charcoal and elution with aqueous pyridine. Paper chromatography of such preparations and of the original brews were then run in a *n*-butanol/acetic acid/water system according to Crammer's technique[4]. The

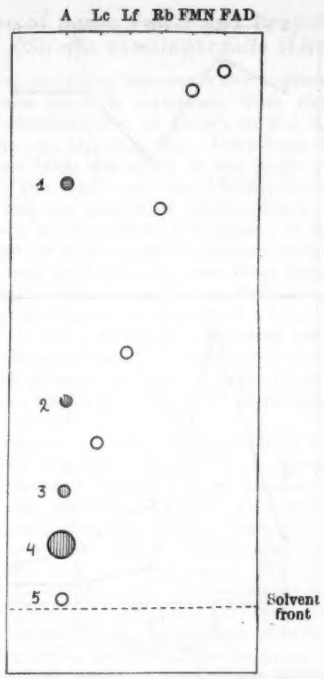

Fig. 1. Paper chromatogram developed with *n*-butanol/acetic acid/water (3 : 1 : 1, v/v). *A*, Sample; Lc, lumichrome; Lf, lumiflavine; Rb, Riboflavin; FMN, flavin-mononucleotide; FAD, flavin-dinucleotide. Areas shaded with vertical lines indicate yellow fluorescence, horizontal lines blue fluorescence and unshaded areas yellow colour without fluorescence

chromatograms showed at least four spots characterized by fluorescence under Wood's light but none could be identified either with riboflavin or its nucleotides or decomposition products (Fig. 1). Only spot 2 reacted with ninhydrin. When the spots were cut off the chromatograms and tested individually, only spot 1, characterized by a blue fluorescence, proved capable of sustaining the growth of *L. casei*.

Further work on the identification of the new flavin is proceeding, and will be reported in detail elsewhere.

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Junction of the Epidermis and Dermis

AT the surface of the dermis, fine fibres form a continuous subepithelial network[1]. These fibres, unlike the underlying coarser fibres, are argyrophilic and also stain red with periodic acid–Schiff technique[2] (Hotchkiss's method[3]). Into this network, processes from the basal epidermal cells project, and it has been reported that the interlocking of these processes with the dermal fibre is a means by which the epidermis adheres to the dermis[4].

New observations have been made on this junction of epidermis and dermis in the skin of the ox. The skin from the leg of an ox was freeze-dried about 5 hr. after death. Sections (3–5μ) were stained, without preliminary fixation by Foot's silver method[5] (to demonstrate the surface dermal fibres), followed either by Mallory's phosphotungstic acid hæmatoxylin (to demonstrate the tonofibrils of the epidermis) or by periodic acid–Schiff technique (Hotchkiss's method for the presence of mucopolysaccharide).

In the basal layer cells of the epidermis the tonofibrils ran mainly parallel with the long axis of the cell. These tonofibrils were found to project beyond the base of the cell and to pass between the argyrophilic dermal fibres. In Fig. 1*a* the tonofibrils can be seen to pass between the silver-stained dermal fibres.

Fig. 1. *a*, Tonofibrils of the basal layer cells of the epidermis interlocking with the silver-stained dermal fibres (× 700); *b*, periodic acid–Schiff-positive fibrils projecting beyond the silver-stained dermal fibres (× 900); *c*, periodic acid–Schiff-positive fibrils as a fringe above the silver-stained dermal fibres (×530)

From this observation we may conclude that there is also an interlocking of the tonofibrils of the basal cells, and dermal fibres, as part of the system by which the epidermis adheres to the dermis.

Examining the silver-stained sections counter-stained with periodic acid–Schiff reagent, no homogeneous periodic acid–Schiff-positive layer, as reported by Gersh and Catchpole[6], was observed between the dermis and epidermis. However, fine periodic acid–Schiff-positive fibrils were observed to extend from the silver-stained dermal fibres and to project into the epidermis. These fibrils appeared to be continuous with the dermal fibres and to be free ending. They varied in length, the longer fibrils at the tips and base of the papillæ. No epidermal structures were stained in these preparations. Fig. 1*b* shows these fine fibrils projecting beyond the silver stained dermal fibres. Fig. 1*c* shows at a lower magnification the fibrils forming a fringe above the dermal fibres.

Such free-ending periodic acid–Schiff-positive fibrils extending from the subepithelial argyrophilic network have not previously been described. As the fibrils stained intensely with periodic acid–Schiff reagent we may conclude that they are closely associated with mucopolysaccharides, and so it is unexpected that the silver failed to deposit on them. The relationship of these fibrils with the epidermal cells remains to be established.

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Enzyme Changes in the Ageing Periosteum

Acid and alkaline phosphatase, cytochrome oxidase and succinic dehydrogenase activities of the periosteum of the femora of 100 normal and 100 traumatized animals were studied histochemically. The animals ranged from newborn to more than one year of age. Trauma was induced by drilling a hole in the midfemoral region.

A steady state of phosphatase activity was revealed in the osteogenic layer of the periosteum of normal animals except for a slight rise at a time comparable to the period of maximum bone formation and a reduction at about the time of sexual maturity. Animals exhibited a rise in dephosphorylating activity throughout the different age groups at the trauma site (Fig. 1, top).

The respiratory enzyme activity of the periosteum of normal animals was high at birth and increased at five weeks; a drastic reduction, however, was observed in all the older animals. At the site of trauma an increase in respiratory enzyme activity occurred but to a lesser degree with increasing age of the animal (Fig. 1, bottom).

Zorzoli[1] has reported an increase in acid phosphatase activity in the cells of old animals. Weinbach and Garbus[2] have shown that in the liver and brain of old animals the respiratory level was maintained.

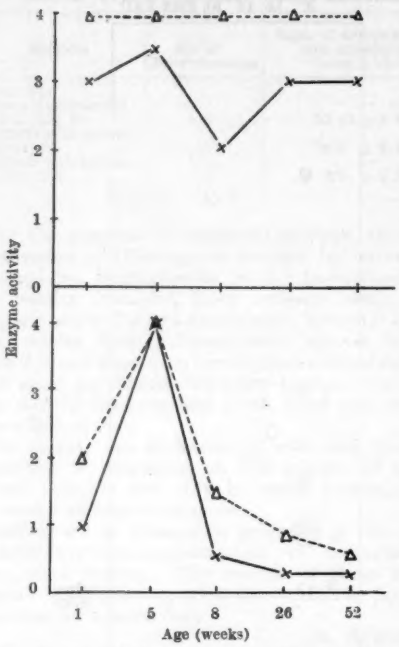

Fig. 1. Enzyme activity based on intensity of precipitate and colour in the osteogenic layer of the periosteum of rat femora taken at different ages. ×, Normal periosteum; Δ, traumatized periosteum. Top, phosphatase activity; bottom, respiratory enzyme activity

This was supported by Bourne[3]. Bourne[4] further indicated that there was evidence of some increase in cytochrome oxidase and succinic dehydrogenase activity in the tissues of older animals.

It appears that, at least in the periosteum of rats, phosphatases do not increase with ageing, and the respiratory enzyme activity decreases to a low level. This is further supported in the observation that the cells of the periosteum of traumatized animals are less able to increase their respiratory enzyme activity with increasing age to levels seen in younger animals.

Bourne[3] states that the consequence of dephosphorylation of metabolically important substances may be behind the fundamental processes involved in cellular senescence. Trauma to bone at any age leads to increased dephosphorylation which is essential for bone repair mechanisms. This brings renewed life to an injured area. The respiratory enzymes, however, are associated with the reactions which make energy available to cells for various activities. The reduction in the activity of these enzymes is believed to be involved with cellular changes which bring about the gradual disappearance and death of the osteoblasts, which in turn reflect a reduction in bone repair rate and growth with increasing age.

The present results will be published elsewhere in greater detail.

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Ovaries of Some Fœtal and Prepubertal Giraffes (*Giraffa camelopardalis* (Linnæus)

In several species of mammals the ovaries of near-term fœtuses show a departure from the typical pattern of development as known in the laboratory rodents, the cat, the dog, etc. Deviations from this normal have been described in the fœtal gonads of the horse[1], the seal[2] and the African elephant[3], in which species an enormous development of interstitial cells is a characteristic feature. A premature development of large ovarian follicles, with antrum formation and luteinization, has been described in the human full-term fœtus[4–9]. Follicle development up to antrum formation appears to be a constant occurrence in the ovaries of near-term fœtal sheep (personal observations), and can occur in the cow[9]. The morphogenesis of the giraffe fœtal gonads provides yet another example of a departure from the normal pattern.

We have examined three stages in the development of the gonads of the female giraffe. So far as we can ascertain, these represent the mid-gestation, late-gestation and new-born periods. In many respects the histological structure of the ovaries of the late-gestation specimen *C.R.* = 1,040 mm. (at birth approximately *C.R.* = 1,162 mm.), Fig. 1,1, recalls that of an adult mammal. The germinal epithelium is cuboidal, there is a well-developed definitive tunica albuginea containing an abundance of both collagen and reticular fibres, the primary follicles are relatively few in number, and many appear shrunken and degenerate. In the medulla there are a number of apparently normal follicles, some of which have a large antrum and a well-developed discus proligerus; the largest is illustrated in Fig. 1,1. Hæmorrhagic follicles of various sizes are present in both ovaries as well as a number of corpus luteum-like structures (Fig. 1,1). These latter are solid, spherical bodies well vascularized and surrounded by a theca externa. The luteinized cells are of two types easily distinguished by their staining affinities, in sections stained in hæmatoxylin and eosin, and also by their size. It is of interest, therefore, to find that in all the adult giraffe ovaries so far examined by us the luteal cells of the corpora lutea of pregnancy show a similar dimorphism. Moreover, in the corpora lutea of pregnancy the proportion of large to small luteal cells appears to reflect the age of the structure. The impression is gained that in the fœtus the luteal bodies are of two forms, one in which the small cell type is prominent and a second in which it is less conspicuous. Besides these solid structures, there is what appears to be a luteinized follicle with a large central cavity (Fig. 1,1).

In the medullary stroma of the fœtal ovary of late gestation, a few discrete, spherical masses of granulosa-like cells surrounding a centrally or eccentrically placed oocyte are also present. These structures are penetrated by large sinusoidal capillary vessels, and contain a conspicuous network of reticular fibres (Fig. 1,2). In the ovaries of two mid-term fœtuses (*C.R.* = 485 mm. and *C.R.* = 620 mm., respectively), these last-mentioned structures, together with what appear to be normally developing follicles, are prominent features in the medulla, and in some of the follicles antrum formation has begun. In the older of the two specimens there is one exceedingly large hæmorrhagic follicle and several smaller ones. No such structures are present in the younger specimen. Surrounding the centrally placed follicles in both

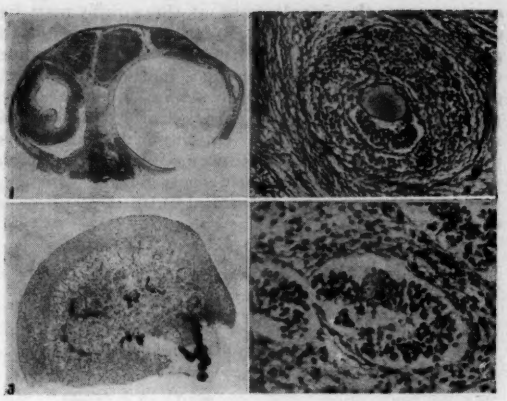

Fig. 1. (1) Section of a late gestation giraffe fœtal ovary showing luteinization, and advanced follicular development (× *c.* 1·5); (2) reticular fibres and capillary vessels penetrating a mass of granulosa-like cells which surround a centrally placed ovum (× *c.* 85); (3) section of a mid-gestation giraffe fœtal ovary showing a wide cortical region separated from the central medullary core by a zone of connective tissue which contains relatively few sex cells (× *c.* 4); (4) rete ovarii with contained ovum from a mid-gestation giraffe fœtal ovary (× *c.* 160)

specimens and separating them from the cortex is a prominent zone of connective tissue (Fig. 1,3). The cortex of both ovaries is wide, and consists largely of closely packed primary follicles embedded in a small amount of connective tissue. The germinal epithelium, in the few places where it is undamaged, is simple and cuboidal. Lying immediately below, and penetrated in most places by connective tissue elements, are epithelial cells and a small number of sex cells not yet in the primary follicle stage. A few of the innermost of the cortical primary follicles appear to have penetrated into the subadjacent connective tissue zone, and even into the more centrally placed medullary core. There are signs of degeneration in many of the oocytes both in the primary follicles of the cortex and in the primary and more advanced follicles of the medulla.

Whether the spherical masses of granulosa-like cells penetrated by capillaries and surrounding an oocyte, which are so striking a feature of the medulla in the mid-term ovaries, are derived from a current cortical proliferation or are medullary derivatives is not yet clear. In places these structures occur in the neighbourhood of, and are closely associated with, the rete ovarii, the cells of which are separated, in places, by the occurrence of germ cells of various sizes (Fig. 1,4).

The ovaries of the two new-born giraffe specimens in our collection both contain large apparently healthy follicles with antra, large luteinized follicles, and numerous corpus luteum-like structures. These findings, together with the observations of a broadly similar picture in the ovaries of older prepubertal specimens, suggest that the developmental stages we have outlined above are a normal feature of ovarian development in this species.

The endocrinological implications of some of these findings, particularly as they are related to the fœtal gonads of late gestation, have been discussed by Amoroso[10–12]. From the foregoing observations on the giraffe fœtal gonads, and others we have made on the fœtal reproductive tracts, it seems clear that both are sensitive to hormonal stimulation for some time before birth, and, as gauged by the histological

appearances, the fœtal ovary of the giraffe may be capable of adult secretory functions in addition to gametogenic functions. In view of the similar character of the ovarian changes in the human and giraffe ovary at birth, the occurrence of gonadotrophins in the urine of pregnant giraffe[13] becomes a matter of special interest. On the other hand, it is possible to envisage an endocrine picture in which maternal (or placental) œstrogen acting directly, or indirectly through the fœtal pituitary, plays a dominant part.

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Avoidance of 'Secondary Disease' in Radiation Chimæras

In the experience of this laboratory the radiation chimæras[1], produced by irradiating *CBA* mice with 950 rads of X-rays and then injecting them intravenously with bone marrow from $C_{57}BL$ mice, invariably die within 4 months from 'secondary disease'. Congdon *et al.*[2] have worked on the lines that this condition might be due to recovery of the host animals' capacity to eliminate the foreign graft. We[3] and Uphoff[4] have favoured the idea that it was due to reaction by the graft against the host.

To test the latter hypothesis with its corollary that material from immature donors may be less reactive, similar irradiated *CBA* mice (950 rads of X-rays; 250 kV. constant potential, 15 m.amp., half-value layer 1·2 mm. copper, 43 rads/min. at 70 cm.) have been given myeloid tissue from fœtal and newborn $C_{57}BL$ mice with the following results (Table 1).

Two of the survivors in group (*b*) and seven of those in group (c), when they had survived more than three months and were in good condition, were grafted with skin from $C_{57}BL$ mice of the same stock. One animal died (? pylephlebitis) during the procedure of deplastering, one skin graft was shed after ten days; the other seven grafts were intact after 2 months.

Table 1. Survivors of Irradiated *CBA* Mice (950 rad X-Rays) given Myeloid Tissue from $C_{57}BL$ Mice

Myeloid tissue given	Survivors at 120 days
(a) Acult bone marrow	0/30
(b) Newborn spleen	11/20
(c) Embryo spleen	9/15
(d) Embryo liver	4/10

These results are in accord with our original hypothesis.

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Transformation of Megaloblasts to Normoblasts by cultivating Human Bone Marrow in Presence of Vitamin B_{12} and Vitamin B_{12}-binding Protein

Callender and Lajtha[1] observed that little or no conversion of megaloblasts to normoblasts occurred when pernicious anæmia marrow was cultivated in pernicious anæmia serum by itself or together with vitamin B_{12}. However, if bone marrow is cultivated in pernicious anæmia serum containing vitamin B_{12} and normal gastric juice or in normal serum with vitamin B_{12} megaloblasts are partly converted into normoblasts within twenty-four hours. Swan *et al.*[2] did not find this influence of vitamin B_{12} and gastric juice, but Astaldi and Cardinali[3] have recently confirmed the findings of Callender and Lajtha[1].

We cultivated human megaloblastic marrow in suspension in pernicious anæmia serum or in normal human serum as described by Osgood[4] and Lajtha[5], and were able to confirm the findings of Callender and Lajtha[1] and Astaldi and Cardinali[3].

It seems that the effective principle in gastric juice and normal human serum necessary for the activity of vitamin B_{12} in the conversion of megaloblastic marrow to normoblastic marrow is the vitamin B_{12}-binding protein. By zone electrophoresis or fractionation with ammonium sulphate we prepared vitamin B_{12}-binding protein from normal gastric juice. When this was added to the bone-marrow cultures together with vitamin B_{12}, the conversion of megaloblastic marrow to normoblastic marrow showed decisive improvement. In some of these cultures we found 50 per cent of the nucleated red cells as normoblasts after twenty-four hours. In the same cultures containing only vitamin B_{12} there were no normoblasts at all. Bone marrow cultivated in normal human serum with vitamin B_{12} contained about 10 per cent of the nucleated red cells as normoblasts after twenty-four hours. The effect was not achieved when some other protein of gastric juice, having no binding capacity for vitamin B_{12}, was added to the cultures. Due to its binding capacity for vitamin B_{12} the α-globulin fraction of normal human serum also showed a marked effect on the conversion.

These investigations were performed on bone-marrow cultures of nine patients with pernicious anæmia in relapse and all yielded the same results.

Further particulars of this work will be published elsewhere.

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Occurrence of Foldings of Plasma Membrane (β-Cytomembrane) in Cells of Pig's Carpal Organ as revealed by Electron Microscopy

The carpal organ of the pig is a conglomerated sweat gland, and histologically it is known to be similar to the usual small sweat gland (eccrine gland)[1]. This organ is useful for investigating the fine structure of sweat glands with the electron microscope, since the conglomerated body of the gland is easily seen with the naked eye and most of the glandular tissue is found within the small field of the electron microscope. The tissue was fixed in 1 per cent osmic acid and buffered at *p*H 7·4 with acetate–veronal or phosphate buffer, washed for a short time and then dehydrated with ethanol in a graded series of concentrations. The specimens were embedded in a mixture of *n*-butyl and methyl methacrylate (7 : 3), and were cut into sections less than 0·05μ thick with a thermal expansion microtome (*JUM*-4) fitted with a glass knife. Embedded sections were examined in a *JEM*-3 electron microscope.

The presence of two kinds of glandular cells in the secretory portion of eccrine sweat glands has already been demonstrated by light microscopy in both human and certain mammalian skins, as well as in the carpal organ of the pig[1–3]. Dark cells, which are observed with the light microscope to contain a number of secretory granules stainable with iron-hæmatoxylin and are periodic acid–Schiff positive, show a number of large electron-lucent vacuoles, which may correspond to the dark-stained granules seen with the optical microscope. While the cells which are clear in light microscopy are rather dark under the electron microscope, secretory granules of this cell type were seen as relatively small, extremely dense granules (Fig. 1).

The free surface of both types of cell is covered by microvilli which are rather irregular in shape when compared with those of the brush or striated border seen in the proximal convoluted tubule of the kidney or intestinal epithelium. The development of microvilli is less marked on the dark cells than on the clear cells (Fig. 1). This was also observed with the light microscope[1].

In the basal cell zone and the lateral boundaries of both cell types, complicated foldings of the plasma membrane were observed (Figs. 1, 2 and 3); this is analogous to the structure called the "β-cytol membrane" by Sjöstrand[4]. The folding at the lateral cell margin is less developed than that of the basal one. The folding in the basal cell zone facing the myoepithelial cell or the basement membrane is similar to the basal infoldings observed in the proximal convoluted tubule of the kidney, the epithelium of the duct of some salivary glands, ependymal cells of the choroid plexus, and in the ciliary body of the eye, all of which are thought to be closely associated with water transport[5]. This suggests that these cells are also associated with the active transport of water from the surrounding connective tissue and blood capillaries into the lumen of the gland producing the sweat, that is, the dilution of the secretory product.

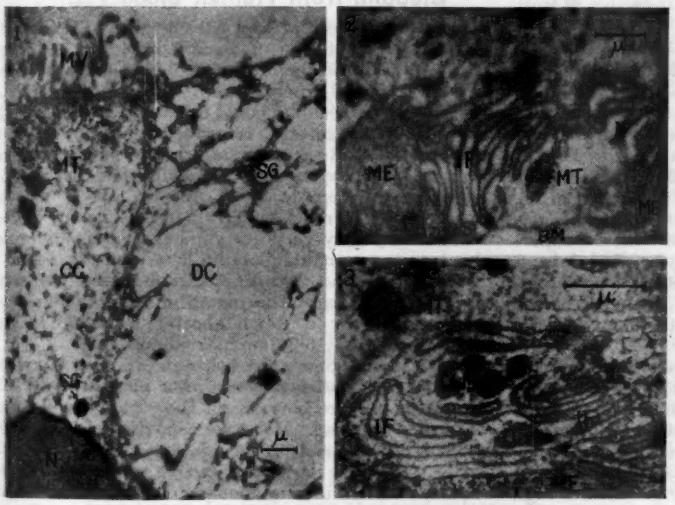

Fig. 1. An electron micrograph of apical and intermediate zone of two adjacent glandular cells (*CC*, clear cell; *DC*, dark cell). *MV*, microvilli; *MT*, mitochondria; *SG*, secretory granules; *N*, nucleus. Figs. 2 and 3. Electron micrographs of nasal portion of the glandular cell, showing the elaborated infolding (*IF*) of basal plasma membrane. *MT*, mitochondria; *ME*, myo-epithelial cells; *BM*, basement membrane

The α- and γ-cytomembranes[4] (called the rough and smooth surfaced varieties of endoplasmic reticulum by Palade[6]; the latter is also identical to the Golgi complex of Dalton[7]) as well as mitochondria are also contained in both glandular cell types. The features corresponding to the various states of the secretion cycle will be described elsewhere.

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Physical Release of Acetylcholine from the Thoracic Nerve Cord of *Periplaneta americana* L.

Recently, suggestions have been made that acetylcholine in nerve tissue is associated with structural entities termed 'vesicles'[1]. The ideas are compatible with a quantum concept of nerve transmission[2]. The evidence that acetylcholine is released from mammalian nerve tissue by physical means[3] lends further support to the structural inclusion of acetylcholine within the nerve cell and casts doubt on the hypothesis that it is held in chemical combination. The following results on the release of acetylcholine from cockroach thoracic cord by osmotic pressure and homogenization makes the existence of a chemical combination in insects doubtful.

Table 1. Effect of Osmotic Pressure on Amounts of Acetylcholine in Supernatant and Residues of Homogenates of Cockroach Thoracic Cord

Extraction molarity with medium homogenization (17 sec.)	Acetylcholine			
	Total (μgm.) (15 cords)	Supernatant (μgm.)	Residue (μgm.)	Supernatant (per cent)
Distilled water	5·75	4·75	1·0	82·6
0·244 *M* Ringer	4·57	3·18	1·39	69·5
0·314 *M* Ringer	4·68	2·85	1·83	60·8

The results in Table 1 show the effect of extraction media of different osmotic pressures on the amounts of acetylcholine recovered from supernatants and residues of homogenates of thoracic cords of cockroaches. The cords were homogenized for 17 sec. in ice-cold medium and centrifuged at 50,000*g* for one hour. Assays for acetylcholine were carried out on frog rectus abdominus muscle, and the values are expressed as chloride. It is clear that both the supernatant and residue values for acetylcholine depend upon the tonicity of the extraction medium. The relatively hypertonic medium, 0·314 *M*, which gave the lowest supernatant value, has the equivalent osmotic pressure of Hoyle's insect Ringer. Furthermore, desheathed cockroach ganglia do not swell at this osmotic pressure. Having established an extraction medium apparently suitable to this insect nerve tissue a combination of homogenization and osmotic pressure was employed to release acetylcholine. The results are shown in Table 2. It is striking that the hypotonic medium, distilled water, released a high proportion of acetylcholine into the supernatant, whatever the severity of homogenization. In the instance of the hypertonic medium more acetylcholine was released into the supernatant with increasingly severe homogenization, until the value for acetylcholine in the supernatant approximated that of distilled water. It should be noted that in either medium it was not possible to obtain all the acetylcholine in the supernatant at severe homogenization.

It is concluded from these results that acetylcholine in cockroach thoracic cord can be released by both osmotic pressure and mechanical disruption. The ease with which acetylcholine can be released in insects supports the suggestion that in insects it can be released more easily than in mammals (Pal, R., unpublished). The evidence favours the hypothesis that acetylcholine is not in chemical combination in insects but located in the nerve cell within a 'structural compartment'.

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Method of isolating the β_1-Metal-combining Globulin from Human Blood Plasma

Surgenor, Koechlin and Strong[1,2] have described the isolation of the β_1-metal-combining globulin (siderophilin, transferrin) from Cohn's plasma fraction IV–4 by alcohol fractionation. The crystallization, described by Koechlin[2], could not easily be reproduced by other investigators. Improved conditions for the purification and the crystallization starting from fraction IV–7 have recently been published by Inman[3]. Already the preparation of fraction IV–7 requires many steps and much time, which may be one of the reasons why only very few clinical experiments with this iron-transmitting globulin have been reported.

We have found that an electrophoretically almost pure preparation of the metal-binding globulin can be obtained by a much shorter procedure using rivanol (2-ethoxy-6,9-diaminacridinelactate).

Hořejši and Smetana[4] have shown recently that rivanol precipitates from serum or plasma at *p*H 7·3 almost all the proteins except the γ-globulin (2 parts of plasma + 7 parts of 0·4 per cent rivanol solution at room temperature). After adsorption of the rivanol by charcoal, the γ-globulin can be precipitated from the supernatant in very good yield under conventional conditions.

We have found that the supernatant of the rivanol precipitation contains significant amounts of albumin and a highly soluble β-globulin besides γ-globulin. The higher the *p*H during the rivanol precipitation, the smaller are the amounts of albumin found in the supernatant. Between *p*H 8 and 10 albumin is precipitated almost quantitatively, while the supernatant still contains γ-globulin and the soluble

Table 2. Effect of Homogenization and Osmotic Pressure on Amounts of Acetylcholine in Supernatants and Residues of Homogenates of Cockroach Thoracic Cord

Degree of homogenization	Acetylcholine							
	Distilled water				Insect Ringer 0·314 *M*			
	Total (μgm.) (15 cords)	Supernatant (μgm.)	Residue (μgm.)	Supernatant (per cent)	Total (μgm.) (15 cords)	Supernatant (μgm.)	Residue (μgm.)	Supernatant (per cent)
Light (5 sec.)	5·85	4·35	1·5	74·3	5·43	2·9	2·53	53·4
Medium (17 sec.)	5·75	4·75	1·0	82·6	4·68	2·85	1·83	60·8
Waring blendor (1 min. at 16,000 r.p.m.)	5·5	4·5	1·0	81·8	5·05	3·3	1·75	65·3
Medium + Waring blendor	4·65	4·28	0·37	92·0	4·52	3·86	0·66	85·4

β-globulin. From the rivanol-free solution the γ-globulin is precipitated in the presence of 25 per cent ethanol at *p*H 6·8 (−6° C.), whereafter the β-globulin is carried down by 40 per cent ethanol at *p*H 5·8. Further purification of the β-globulin can be achieved by dissolving it at *p*H 9·4 (4–6 per cent protein) and repeating the rivanol procedure. From 100 gm. plasma proteins about 2 gm. of β-globulin almost pure paper-electrophoretically were obtained.

The deep red-brown colour of the solutions of this β-globulin fraction is characteristic of the iron-combining protein. Normally it is only partly saturated with iron. By dialysis against versene (ethylenediaminetetraacetate) it can be freed from iron and thereby becomes colourless. Quantitative determinations of the iron-binding capacity have shown that the preparations obtained in this simple manner consist to about 90 per cent of metal-combining globulin. So far as their purity is concerned, these preparations therefore correspond to fraction IV-7-2.

We think that the high solubility of the β_1-metal-combining globulin in the presence of rivanol above *p*H 7 makes this reagent a very suitable tool to prepare larger amounts of this interesting protein for clinical experiments.

Details of our studies, which are being continued, will be published later.

This work was supported by the Swiss National Science Foundation.

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Soluble Antigens in Microsomes and Other Cell-Fractions of Rat Liver

It has been known for some time that particulate material sedimentable by high speed from tissue cells has characteristic immunological properties, and the antigenic specificity of isolated cell fractions has been studied in a variety of normal and tumour tissues[1]. These investigations not unexpectedly revealed a high degree of antigenic complexity of the different cell fractions, making further analysis difficult by the methods at hand. However, the results seemed encouraging enough to warrant an extension of the immunological work to the various soluble antigens characterizing different parts of the cell. An investigation of this sort has been carried out in our laboratory, and a detailed report of it will be published later.

The work was carried out on mitochondria, submicroscopic particles and supernatant prepared from liver cells of adult normal rats. For immunization, perfused livers were homogenized in 0·25 *M* sucrose and fractionated by differential centrifugation. Some microsome samples were prepared by the method of Palade and Siekevitz[2]. For control purposes, antisera were prepared also against total homogenate made in 0·9 per cent saline and against rat serum. The concentrated samples were injected as soon as possible after isolation. The antisera were obtained in rabbits using adjuvant techniques for injection.

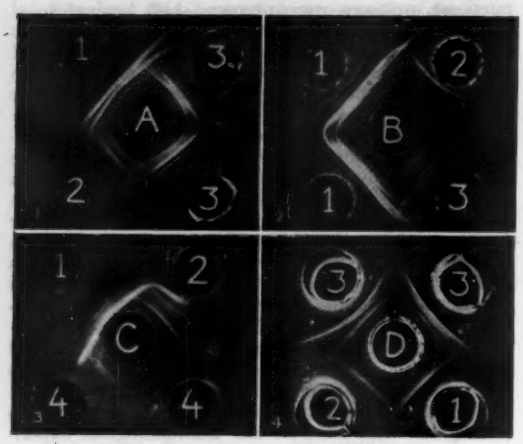
For testing, the cell fractions were prepared similarly, but variations in the conditions of fractionation were studied as separate variables. Mitochondria and microsomes were extracted with 0·4 per cent deoxycholate[2] and the microsomes were further fractionated by means of additional extractions with versene. Since the deoxycholate did not affect the reactivity of the antigens, the extracts could be used for testing without further treatment. The supernatants were tested directly in sucrose or after pressure dialysis against 0·9 per cent saline. Protein and ribonucleic acid determinations were always carried out in order to test the efficacy of the fractionations.

The double diffusion agar-techniques according to Korngold[3] were used in the immunological experiments. Instead of penicillin-cups, small plastic cups with a closed base and with narrow openings close to the base were used as containers for the reagents. The agar layers were poured into Petri dishes on the top of a thin glass slide. The experiments were run at 37° or at 4° C.; one or two fillings were sufficient to ensure strong reactions. After completion of the reactions in the refrigerator, the plates were washed, dehydrated with ethanol, stained and finally dried[4]. The glass slides with the thin agar film on top were removed from the dishes, and the preparations were mounted with liquid plastics under a second slide of the same dimensions[5].

The precipitation patterns obtained in the experiments were often complex and difficult to interpret. The criteria used for identification of the antigens and antibodies were those commonly applied in the Ouchterlony procedure[6]. Our conclusions are based on only those results which could be confirmed by means of independent experimental procedures, including, for example, reciprocal testing, tests at different antigen/antiserum ratios and chemical fractionations of the antigen solutions.

The antisera against both total homogenate and the cell fractions contained only small amounts of antibodies reacting with the proteins of rat serum. Correspondingly, the amount of these antigens in the cell fractions was mostly negligible. In fact the reactions showed an unexpectedly high degree of 'cell-fraction'-specificity. As a general rule, supernatant and deoxycholate extracts of mitochondria and microsomes gave the strongest and most complex precipitation patterns with their homologous antisera (Figs. 2–4). Entirely confirmative results were obtained with the anti-total homogenate sera (Fig. 1). The microsomes were 'strongest antigenic', probably due to lesser stability of both the mitochondrial preparations and the supernatants. This report deals mainly with the immunological properties of the microsome preparations.

The deoxycholate extracts of the microsomes were characterized by a group of antigens, occurring abundantly and predominating also as antibody producers (Fig. 2). The minimum number of detectable antigenically different molecules within this group was five. There are reasons for believing that these antigens, which we may call 'D-antigens', constitute an important part of the proteins extractable with deoxycholate from the endoplasmic reticulum of the hepatic cells[2].



Figs. 1–4. Antisera: *A*, anti-total homogenate; *B*, anti-microsomal; *C*, anti-mitochondrial; *D*, anti-supernatant. Antigen solutions: 1, deoxycholate extract of microsomes; 2, deoxycholate extract of mitochondria; 3, supernatant; 4, rat serum

Whereas the supernatants were essentially free from these D-antigens, the situation was more complicated for the mitochondria. Thus, the anti-mitochondrial sera contained a certain amount of antibodies reacting with the D-antigens in the microsomal extracts, but the concentration of the antibodies was lower here than in the anti-microsomal sera. Apart from antigens characteristic of mitochondria only, deoxycholate extracts of the mitochondria contained D-antigens in relatively small amounts (Fig. 3), varying from preparation to preparation. This might indicate that the presence of the D-antigens in the mitochondrial preparations was due to contamination with endoplasmic reticulum[7], although thus far other explanations cannot be excluded.

Apart from these D-antigens, the deoxycholate extracts of the microsomes contained an additional number of antigens in common with supernatant, and reacting with antibodies in both anti-microsomal and anti-supernatant sera (Fig. 4). In contrast to what has been found for the D-antigens, the distribution of these antigens between the microsome fraction and the supernatant was highly dependent on such variables in preparation as time and speed of centrifugation, sucrose concentration, washing, etc.

Versene extracts of the microsomes contained relatively little in common with the deoxycholate extracts. A certain number of distinguishable antigens, occurring in small amounts and generally not detectable in the deoxycholate extracts, could be found when these extracts were allowed to react with anti-supernatant serum. It cannot yet be stated whether these antigens represented contaminating proteins derived from the supernatant or whether they were common to both fractions in a more functional sense.

Naturally, a considerable amount of work remains to be done for a complete characterization of the main soluble antigens of the liver cell. However, the results reported here are sufficient to show that the striking differences between the antigens make it possible to analyse the cell fractions by the methods described above. Hence, in combination with common biochemical techniques, these methods should offer a valuable tool for testing the efficacy of a cell-fractionation procedure. Furthermore, they seem particularly well suited for a study of the genetic relationship between different elements of the liver cell. Finally, it should be pointed out that a combination of the immunological techniques with work on the incorporation of isotopes should be particularly suited for an investigation of such problems as protein synthesis *in vitro* in isolated cell fractions. Studies along these lines are in progress.

We are indebted to Dr. T. Hultin for valuable discussions and advice.

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Variations in the Erythrocyte Potassium and Sodium in the Possum, *Trichosurus vulpecula*

The ratio of the concentration of sodium ions to that of potassium ions in erythrocytes has been recorded for numerous animal species. In most cases, the relation between the concentrations of sodium and potassium is of the same order for individuals of any one species[1]. This uniformity between individuals, however, does not exist in sheep. Evans[2] has summarized the previous work on sheep, and his own results show three distinct types of sheep, according to the concentrations of potassium and sodium in the erythrocytes, in the various breeds he examined. Evans and King[3] had already shown that variations in concentrations of these ions in sheep erythrocytes were determined by a single-gene substitution.

There has so far been no demonstration of similar variations in any wild population of animals. The results presented here show marked variations in the erythrocyte concentrations of sodium and potassium between individuals of a marsupial, the brush-tail possum, *Trichosurus vulpecula*.

The animals used were trapped in the suburbs of Perth, Western Australia, and of Adelaide, South Australia. (Samples from Adelaide were kindly sent by Mr. J. Eadie, Department of Zoology, University of Adelaide, South Australia.) Blood was collected by heart puncture into heparinized syringes. The Perth samples were treated as follows: for indirect estimation of ionic concentrations in the erythrocytes from whole blood and for plasma values, a portion of the whole blood was separated soon after collection, the remainder was centrifuged and the plasma decanted immediately; the cells separated by

Table 1. Comparison of Direct and Indirect Methods for Evaluation of Concentrations of Sodium and Potassium Ions in Erythrocytes for Twenty-seven Perth Possums

Group	No. of animals	Sodium (m.equiv./l.)			Potassium (m.equiv./l.)		
		Cells		Plasma	Cells		Plasma
		Direct method	Indirect method		Direct method	Indirect method	
High [K⁺]	7	36·3	36·8	157·2	103·8	101·2	5·9
Low [K⁺]	20	129·6	124·7*	160·7	10·3	10·9*	5·7

* Mean value for sixteen animals only.

centrifugation were prepared for direct estimation of the concentrations of sodium and potassium ions by three washes with isotonic glucose and then resuspended in isotonic glucose for hæmatocrit estimation. Cell samples sent from Adelaide were prepared by two washes with isotonic sucrose after preliminary separation of plasma, followed by 1 : 1 dilution of cells with distilled water. Hæmatocrit estimations were made in duplicate or triplicate using metal-sheathed micro-tubes spun at 3,000 r.p.m. for 30 min.; concentrations of sodium and potassium ions were determined with an EEL flame photometer.

The concentrations of sodium and potassium ions in the erythrocytes of 42 possums (27 from Perth, 15 from Adelaide) determined by the direct method are plotted in Fig. 1. There is a clear-cut division of the animals into two groups, one with a high concentration of potassium and a low concentration of sodium in the erythrocytes (21 animals) and the other with a low concentration of potassium and a high concentration of sodium in the erythrocytes (21 animals). Some of the Western Australian possums were sampled repeatedly over periods up to three months. The variations between samples from the same animal were small compared with differences between the two groups. The mean sum of the concentrations of the two ions for individuals is approximately 30 m.equiv./l. lower in the Adelaide sample than in the Perth sample. This can probably be accounted for by differences in the preparation of the cell samples from the two areas.

Table 1 records the mean concentrations of sodium and potassium ions for the two groups of the Perth sample, determined by the direct and indirect methods, which give results in close agreement.

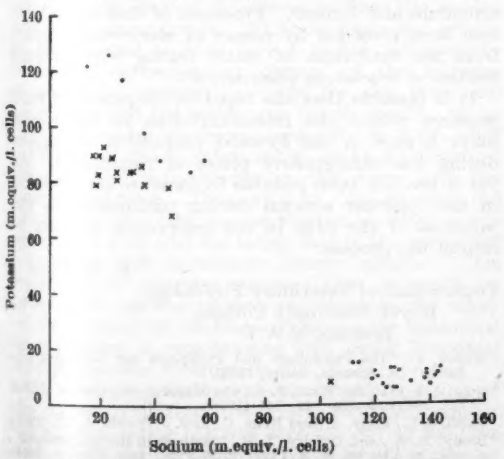

Fig. 1. Erythrocyte concentrations of sodium and potassium ions for 27 Perth possums (●) and 15 Adelaide possums (×), each point representing one animal

The animals from Perth and Adelaide constitute samples of two geographically isolated populations. The ratio of animals exhibiting a high concentration of potassium to animals exhibiting a low concentration of potassium is quite different in the samples from the two areas, being roughly 1 : 3 in the Perth sample and 14 : 1 in the Adelaide sample. The frequency of the different types of sheep varies with breed and geographical distribution[3], and it will be of interest to see what frequencies of cell types occur in possum populations in areas of Australia not so far sampled.

The two cell types reported here for the possum correspond most closely to the Evans α- and γ-types in sheep. Breeding experiments are in progress to determine whether genetic differences are responsible for the different types of erythrocyte in the possum.

The possibility of there being different types of hæmoglobin in the possum, as in the sheep[4], was suggested by Mr. R. L. Kirk (Department of Zoology, University of Western Australia), who has so far tested samples from fourteen of the Perth possums. No differences in type of hæmoglobin have been observed in this preliminary investigation.

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Reproduction of Fused Larvæ in the Boring Sponge, *Cliona celata* Grant

Larvæ of the sponge *Lissodendoryx carolinensis* fuse with each other if brought together in culture dishes, and some of the compound larvæ metamorphose[1]. Nevertheless, one would rarely expect such an event in Nature, as most sponge larvæ are released a few at a time, and disperse rapidly. In *Cliona celata*, however, I have observed successful reproduction by fused larvæ in a much more natural environment than a culture dish.

Throughout the summer of 1955, I kept several oyster shells containing boring sponges in an asphalt-lined wooden aquarium through which seawater constantly flowed. The water was pumped from the bottom of the Bideford River, Prince Edward Island, an estuary in which *Cliona* was growing, and did not change appreciably in temperature or lose suspended matter during its passage to the aquarium. *Microciona prolifera*, a sponge much more sensitive to stale water than *Cliona*, lived indefinitely and reproduced freely in a similar tank.

Under these conditions, *C. celata* (which is oviparous) may discharge tens of thousands of eggs from a large osculum in a few hours. The eggs are sticky, and adhere to each other and to the substratum in an irregular flattened mass. Diatoms, the shells of larval molluscs, silt and other debris rapidly accumulate on and in the mass, so that on hatching many of the larvæ are temporarily trapped, able to wander among the interstices of the egg mass but delayed in their escape to open water. In their wanderings, the larvæ sometimes come together in twos or threes and fuse. Fusion is without apparent regard for polarity, so the swimming movements of compound larvæ are often merely ineffective gyrations and many perish within the tangle of debris. A few escape, however, since two such compound larvæ metamorphosed successfully into single sponges, with single oscula, and began boring in crystals of calcite placed near an egg mass.

It seems quite possible, then, that *Cliona* larvæ occasionally metamorphose after fusion, in their normal environment. The natural occurrence of larval fusion, previously dismissed as a purely experimental phenomenon, emphasizes its interest to students of individuation and related problems of theoretical morphology.

This observation is part of a study of *Cliona* conducted at the Fisheries Research Board of Canada's Biological Sub-Station at Ellerslie, Prince Edward Island, which will be more completely reported elsewhere. I thank other members of the Sub-Station staff for their help.

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Pressure developed within the Reticular Compartment of the Ruminant Stomach

In order to investigate the mechanical aspects of digestion in the ruminant stomach, pressure variations occurring within the reticulo-rumen have been measured on many occasions[1–3], using balloons connected to liquid-filled manometers or to recording tambours. Wester[1] reported that the intra-ruminal pressure in the cow showed phasic fluctuations of 2·5 cm. mercury, while Quin, Van der Wath and Myburgh[2] recorded a maximal rise of 10·0 cm. water in the sheep; in both instances the basal intra-ruminal pressure was close to atmospheric pressure. Balch, Kelly and Heim[3], using a balloon connected to a writing tambour, recorded pressure-changes from within the reticulum of the cow and showed a basic level of 2·5–3·5 cm. mercury above atmospheric pressure rising by 1–2 cm. mercury with contraction of the reticulum. It is probable that in the latter case the higher resting pressure is due to the hydrostatic effect of the liquid contents of the reticulum.

Brody and Quigley[4] have examined the balloon–water manometer technique for measuring intra-lumen pressure in the digestive tract and have demonstrated that inflated balloons and water manometers produce a number of artefacts in the pressure records which become unreliable and inaccurate. Such criticisms could be applied with even greater force to recordings made in this way from the very capacious reticulo-rumen where differential contraction and relaxation of the various subsidiary sacs occurs[5]. Brody and Quigley advocate the use of open-ended small-bore tubes connected to electromanometers as the technique of choice for the accurate measurement of pressure within the gut.

This method has been used for measuring the pressure within the reticulum of the goat using a 'Polythene' tube (2·0 mm. int. diam.) passed into the œsophagus intra-nasally. Pressure variations were registered by means of a Hansen capacitance manometer and d.c. amplifier and displayed by means of an Ediswan pen oscillograph. It was easy to make pressure records while the tube was being manipulated within the alimentary tract, so that entry of the tube into the antrum of the reticulum was indicated precisely by the replacement of the rapid respiratory pressure changes with the slow pressure variations of the reticulo-ruminal contraction cycle.

Pressure records made in this way show the well-known contraction of the reticulum occurring regularly at 43–52 sec. intervals, the pressure rising from near atmospheric level to 50 cm. water or more in 2–3 sec. and falling rapidly in 1–2 sec. to the resting level. Pressures up to 65 cm. water have been recorded, but 50 cm. water was the more common value of intra-reticular pressure recorded from eight goats on numerous occasions. Electromanometer pressure records from the antrum of the reticulum do not show the biphasic peak which is a feature of recordings when balloon–water manometer systems are used deep in the reticulum. Smaller and irregular pressure waves of up to 20 cm. water were also recorded from the reticulum near the cardia, and since these pressures accord with those obtained when the tube is pushed farther posteriorly it is likely that they are produced by contraction of the rumen musculature.

The figure of 50 cm. water reported here, although more than double the value recorded from the reticulum by balloon systems inserted through a rumen fistula, can be regarded as authentic, the disparity being due to the physical characteristics of the recording systems. This new result agrees very well with the pressures evoked in the reticulum following electrical stimulation of that region of the medulla oblongata which exerts control of the reticulum and rumen[6]. Pressures of this order have also been recorded by means of electromanometers from the reticulum of cattle during experimental studies of eructation phenomena[7].

It is possible that the rapid development of high pressure within the reticulum close to the cardia plays a part in the forward propulsion of ingesta during the regurgitative phase of rumination. As yet it has not been possible to measure the pressure in the reticular antrum during rumination as the presence of the tube in the œsophagus appears to inhibit the process.

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Distribution of Radioiodinated, Acetone-killed *Brucella abortus* in the Tissues of Normal and Immune Mice

THE distribution of radioactively labelled antigens in animal tissues has been studied extensively. Most of the work has been done in normal animals, using simple antigens. Few direct comparisons have been made of the distribution of labelled antigens in normal and immune animals, and no work seems to have been done along these lines with a killed bacterial antigen.

Table 1. RADIOACTIVITY IN SELECTED MOUSE ORGANS (PER CENT OF RADIOACTIVITY INJECTED)

Time after administration of radioactive bacteria \ Immunizing dose (mgm.)	Liver			Spleen			Peritoneal membrane			Mesenteric lymph glands		
	None	0·07	0·5	None	0·07	0·5	None	0·07	0·5	None	0·07	0·5
6 hr.	13·5	12·0	7·2	4·2	1·2	0·5	3·2	4·8	8·0	1·7	3·8	5·0
1 day	12·0	3·2	7·6	4·3	0·7	0·7	1·5	3·0	3·5	1·3	6·2	2·0
3 days	6·2	4·1	2·7	2·5	0·6	0·4	1·0	0·9	1·3	1·6	3·2	3·1
6 days	3·2	0·7	1·5	1·6	0·15	0·2	1·5	1·2	0·4	0·4	2·6	1·1

Acetone-killed *Brucella abortus* 2308 was used in the present study, both as immunizing and as test antigen to be followed in the tissues. Mice were immunized by a single subcutaneous injection of 0·07 or 0·5 mgm. bacteria. Two weeks later they were 'challenged' intra-abdominally with 0·4 mgm. radioiodinated *Brucellae* of the same strain. The iodination was carried out with approximately 80 μc. iodine-131, following the technique of McFarlane[1] slightly modified for the present purpose. The material injected had a specific activity of 300,000 c.p.m./mgm. dry weight bacteria, as measured in a 'Tracerlab' well-type scintillation counter. More than 98 per cent of the activity was bound to the bacteria. Six mice of each group were placed in metabolism cages. Three were killed at 6 hr. and three at 24 hr. after 'challenge'. Other groups of three mice were killed at 3 and 6 days after administration of labelled *Brucellae*. A thorough search was made for the injected radioactivity in the internal organs of the mice. The main findings are summarized in Table 1, which shows striking differences between the normal and the immune groups. While the livers and spleens of the normal animals had a higher radioactivity than the corresponding organs of the immune animals, the reverse was true for the peritoneal membrane and the mesenteric lymph glands. Moreover, in several instances, especially at 6 hr. after injection, a direct relationship could be observed between the radioactivity in the organ and the immunizing dose. Thus, at 6 hr., the stronger the immunizing dose the smaller the radioactivity in the spleen and liver and the larger that in the peritoneal membrane and mesenteric lymph glands. This regularity of response suggests that it might be possible to use the present technique in the assay of the potency of vaccines. The similar behaviour of the spleen in experiments with living *Brucellae*[2] strengthens this assumption.

An interesting finding was the rapid excretion of the radioactivity from the body. 35–40 per cent of the injected iodine-131 was excreted during the first 6 hr. Since the radioactivity found in the urine was apparently attached to low-molecular compounds, as determined by dialysis, precipitation of the activity with silver nitrate and lack of precipitation with *Brucella* antiserum, it must be concluded that the excretion was due to a rapid breakdown of the antigen. High excretion-rates of the label have been found by several other workers[3–5].

It appears, therefore, that the animal can use two completely different mechanisms for the destruction of foreign antigenic material, one acting rapidly during the first few hours after injection, the other acting more slowly, after the antigen has been deposited in the organs, presumably through the intervention of the antibody.

Full details of this work will be published.

I am indebted to Mr. G. Rasooly for technical assistance.

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Fibrinolysis Autographs

Permin and Astrup used a plate method of demonstrating fibrinolytic activity[1,2]. This technique can be applied histologically. A thin layer of fibrin is

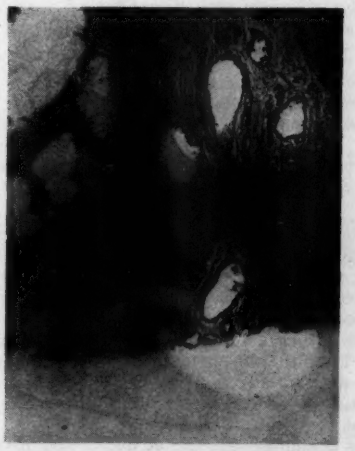

Fig. 1. Section of human prostate showing lysis of fibrin in relation to veins (stained with hæmalum and eosin). × c. 47

made on a microslide by adding a drop or two of fibrinogen to a film of thrombin on the glass. When the fibrin layer has formed, a section of fresh or alcohol-fixed tissue cut on the freezing microtome is applied to its surface and the preparation incubated at 37° C. After 30–60 min. patches of digestion of the fibrin appear in relation to structures possessing fibrinolytic activity. These patches appear as clear zones when the preparations are stained with hæmalum and eosin (Fig. 1), and can be related to the structures in the section.

Of the human tissues so far examined (including thyroid, lung, uterus, ovary, prostate, adrenal, kidney, liver, heart muscle and spleen), all, with the exception of liver, show scattered foci of fibrinolytic activity. These are consistently related to veins or venous sinusoids and, to a lesser extent, arteries, except in the lung, when they are predominantly related to pulmonary arteries.

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Prolongation of the Life of *Drosophila subobscura* by a Brief Exposure of Adults to a High Temperature

The life-span of *Drosophila subobscura* at 20° C. (the temperature at which this species is normally kept in the laboratory) can be increased by exposing adults to a high temperature soon after their emergence from the pupa. But first the results of keeping adults continuously at the same temperature will be described.

It has long been known that the life-span of *Drosophila*, and of poikilotherms generally, decreases with increasing temperature[1,2]. For the F_1 hybrids between the *K* and *NFS* inbred lines of *D. subobscura* the results obtained, for flies kept as mated pairs, and transferred to fresh food at regular intervals, are given in Table 1.

Table 1

Temperature (° C.)	Mean adult life-span (days) Males	Females
20	67·4	55·9
25	27·0	35·5
30·5	7·6	17·6

At temperatures above 31° C. the expectation of life falls very rapidly to less than 24 hr. at 33° C. There are reasons for thinking that the changes which occur in individuals at temperatures above 31° C. are different in kind from those occurring below 31° C. Thus if flies are exposed to 33° C. for 8-hr. periods, with intervening periods of 16 hr. at 20° C., their total survival-time at 33° C. is much greater than that of flies kept continuously at 33° C. In this sense the changes occurring at 33° C. are 'reversible', as are the changes which occur at still higher temperatures[3]. In contrast, changes occurring at 30·5° C.

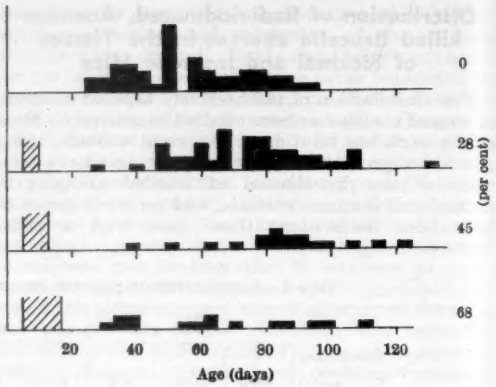

Fig. 1. Ages at death of female *D. subobscura* kept at 20° C., but exposed soon after emergence to 30·5° C. for 0 per cent, 28 per cent, 45 per cent and 68 per cent of their expectation of life at that temperature. Periods spent at 30·5° C. are indicated by hatching

are irreversible, in that the total survival-time at this temperature is not increased by an intervening period of 8 days at 20° C.

Turning to the evidence for a prolongation of life by exposure to high temperatures, Fig. 1 shows the results of exposing adult females soon after emergence to 30·5° C. for 5–12 days (that is, 28–68 per cent of their expectation of life at that temperature) and then returning them to 20° C. Females so exposed lived for up to 50 per cent longer than did females kept continuously at 20° C.

Two conclusions follow. First, the life-span at 20° C. can be increased by exposing adults to 30·5° C. soon after emergence. It seems likely that one effect of this exposure is permanently to reduce the rates of metabolic processes at 20° C. This is suggested by the fact that the rate of egg-laying is much higher in females kept continuously at 20° C. than in females previously exposed for 5 days to 30·5° C.

The second conclusion is that at least two separate processes of senescence can occur in *Drosophila*. By senescence is here meant those changes occurring in an individual which render that individual more likely to die as it gets older; in other words, senescence is measured by the increase in the force of mortality with age. Now there are some environments in which the force of mortality increases with time, but in which the causes of death have little to do with senescence; for example, animals kept without food would in time die, but this would not be regarded as senescence because it is known that if, after a shorter period of starvation, the animals had been fed, they would have recovered completely. For the same kind of reason the reversible changes in flies kept at 33° C. are not regarded as senescence. But it does seem reasonable to regard as senescence the changes which ultimately kill flies kept continuously at 30·5° C., since they are not reversed in individuals returned for a time to 20° C. Now these senescent changes occurring at 30·5° C. (which may or may not be the same as the changes, also occurring at 30·5° C., which increase the subsequent life-span at 20° C.) cannot be the same as the senescent changes at 20° C., since if they were the same they would be expected to reduce rather than to increase the expectation of life at the latter temperature.

It follows that different processes of senescence occur at 20° C. and at 30·5° C. If so, it does not augur

well for attempts to find a single fundamental cause of ageing in this species; by analogy, there may well be a number of different and partly independent processes of ageing in mammalian species, although in a homiotherm these processes would not be so easily separable.

A full account of this work is in preparation. The investigation was assisted by a grant from the Nuffield Foundation.

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Growth and Titration of Louping-ill Virus in Monolayer Tissue Culture of Pig Kidney

Rivers and Ward[1] reported the propagation of louping-ill virus in a Maitland-type culture of chick embryo tissue. More recently, Oker-Blom[2] has described a cytopathogenicity in HeLa cell culture induced by louping-ill which permitted titration of the virus. I have found a specific cytopathogenic effect by the same viral agent in monolayer culture of pig kidney.

The louping-ill virus was a strain isolated and maintained at the Moredun Institute and is used here as infected mouse brain. Virus dilutions were prepared in physiological saline (0·85 per cent sodium chloride) incorporating 10 per cent normal sheep serum, and titrations were carried out intracranially in four 3–5 week old white mice per dilution. Mice were observed for fifteen days following inoculation, and the 50 per cent end-point arrived at by the method of Reed and Muench[3]. The method of culture of pig kidney was that made available by Sellers (personal communication), the trypsin-dispersion of the renal cells having been modified to follow more closely the recommendations of Rappaport[4]. Initial cultures were grown in 'Pyrex' Roux bottles (12 cm. × 20 cm.) by introducing 60 ml. of cell suspension containing 8×10^5 cells per ml. of nutrient medium. The medium comprised Earle's saline, 0·5 per cent lactalbumen hydrolysate (enzymatic) and 0·01 per cent yeast extract; to this mixture was added 10 per cent normal cattle serum as well as antibiotics. By this method almost confluent monolayers were formed by the sixth day of incubation at 35° C. At this time the cells were subcultured into 'Pyrex' tubes (1·6 cm. × 15·0 cm.) containing cover-glasses (0·63 cm. × 2·22 cm.) by introducing into each 0·5 ml. of cell suspension containing 8×10^5 cells per ml. of medium. Cultures were ready for inoculation by the second or third day of incubation, when continuous monolayers were formed. Further incubation was carried out in roller drums.

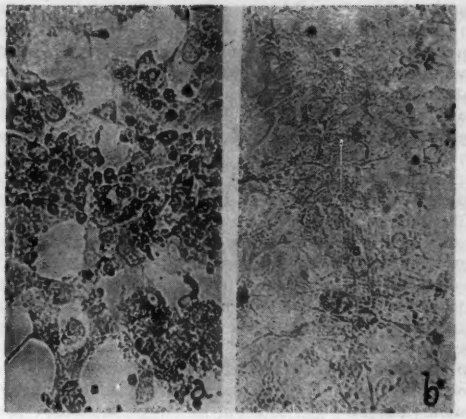

Fig. 1. (*a*) Cytopathogenicity produced in pig kidney monolayer tissue culture by approximately 300 *CPD*50 doses of louping-ill mouse brain virus in the presence of an equal volume of normal sheep serum diluted 1 in 100. (*b*) Normal pig kidney monolayer 'protected' from the same amount of virus by an equal volume of louping-ill hyperimmune sheep serum diluted 1 in 100. The source and age of the cells as well as the period of incubation with virus were identical with (*a*). × 110

Virus was passaged serially in culture by transferring pooled undiluted or diluted infected medium from one group of four to six tube-cultures to each of a group of newly prepared ones. Passage virus was harvested on the sixth day of incubation and titrated immediately in mice. By the fifth passage the original virus inoculum titre of 4×10^4 mouse *LD*50 doses per ml. was diluted 10^7 but yielded $3{\cdot}9 \times 10^7$ mouse *LD*50 doses per ml. Clearly, the cultures were supporting multiplication of the virus. Microscopic examination of live cultures inoculated with low dilutions of mouse brain virus revealed a cytopathogenic effect which commenced on the second to third day. The affected cells became granular, rounded up, and appeared to agglutinate (Fig. 1). As the effect increased in severity, there was almost total cell necrosis and destruction of the monolayers. Fixed coverslip preparations of affected cells stained with Giemsa showed shrinking, pyknosis and disintegration. Uninfected cultures and cultures inoculated with comparable dilutions of normal mouse brain remained unchanged.

Titration of virus in culture on the basis of the presence or absence of cytopathogenicity was carried

Table 1. NEUTRALIZATION OF THE CYTOPATHOGENICITY INDUCED BY LOUPING-ILL MOUSE BRAIN VIRUS IN PIG KIDNEY MONOLAYER TISSUE CULTURE BY SPECIFIC HYPERIMMUNE SHEEP SERUM. SIMULTANEOUS NEUTRALIZATION IN MICE INOCULATED INTRACRANIALLY IS ALSO SHOWN

Test system	Inoculum (ml.)	Quantity of virus	Sheep serum log dilution											
			Normal						Louping-ill hyperimmune					
			Undil.	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	Undil.	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}
Culture	0·1	300 *CPD*50	5/5*	5/5	5/5	5/5	5/5	5/5	0/5	0/5	0/5	0/5	5/5	5/5
Mice	0·05	300 *LD*50	4/4†	3/3	4/4	4/4	4/4	4/4	0/4	1/3	0/4	1/3	4/4	4/4

* Numerator: No. of tube-cultures showing cytopathogenic effect up to the sixth day after inoculation of serum–virus mixture. Denominator: No. of tube-cultures inoculated with serum–virus mixture.

† Numerator: No. of mice killed showing typical symptoms of louping-ill up to the fifteenth day after inoculation of serum–virus mixture. Denominator: No. of mice inoculated with serum–virus mixture.

out by adding tenfold dilutions of mouse brain virus to groups of five tube-cultures. Results were read on the sixth day of incubation under low-power magnification and the 50 per cent end-point calculated as in mice. Mice were inoculated simultaneously with the identical virus dilutions. One cytopathogenic (50 per cent) dose (*CPD*50) was determined to be equivalent to 400–600 mouse *LD*50 doses.

Neutralization of the cytopathogenic effect in culture was carried out both by serum and virus dilution techniques. The results of a test in which tenfold dilutions of sera were tested against approximately 300 *CPD*50 doses and 300 mouse *LD*50 doses of mouse brain virus in cultures and mice respectively are shown in Table 1. Serum–virus mixtures were incubated for 2 hr. at room temperature (22° C.) followed by ½–1 hr. at 4° C. prior to inoculation into the test systems; results were read as before. The marked inhibition of cytopathogenicity by louping-ill hyperimmune sheep serum was regarded as proof of the specificity of the reaction.

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Treatment of Hops with Dimefox

Dimefox, a systemic insecticide, is extensively used in commercial practice for the control of the hop aphis (*Phorodon humuli*) and the hop red spider (*Tetranychus urticae*). Because of toxic hazards it is not used as a spray or dust but is applied via the soil at the rate of approximately 0·5 gm. active ingredient in 120 ml. water per plant or hill. A single application is normally made each season in May or June.

The plants involved in this investigation were grown at Wye at a spacing of 6 ft. 6 in. (2 m.) square on wirework 14 ft. 6 in. (4·4 m.) high. Dimefox was applied to all plants at 0·5 gm. per hill on May 31; a second application at 0·25 gm. per hill was made to some of the plants on July 19. Samples of leaves were collected at different heights at intervals throughout the season up to the time of harvesting, and were analysed in the Department of the Government Chemist. Samples of ripening cones and dried hops were also examined.

It was found that the progress of the insecticide from the soil to the plant could be followed by means of the analytical figures. The rate of travel in the plant itself could be measured by examining leaves from different levels.

The method of analysis used throughout this work was that of Field and Laws[1]. The samples, when picked, were packed in air-tight 'Polythene' bags and were examined immediately on arrival at the laboratory. The results are expressed as p.p.m. on the samples as received, no attempt being made to correct for moisture content.

Table 1. Dimefox Content of Leaf Samples from Treated Hop Plants

Days from treatment	Height of leaves above ground-level		P.p.m. dimefox	
	Bottom sample	Top sample	Bottom sample	Top sample
Control	2 ft.	—	0·1	—
4	3 ft.	—	3·5	—
11	3 ft.	7 ft.	2·2	1·2
18	3 ft.	8 ft.–8 ft. 6 in.	2·5	3·2
32	4 ft. 6 in.	11 ft.	1·6	0·9
39	4 ft. 6 in.	11 ft.	1·9	1·0
47	4 ft. 6 in.	12 ft. 6 in.	0·9	1·0
53 (3)	4 ft. 6 in.	12 ft.	0·8 (2·9)	0·6 (2·0)
58 (8)	4 ft. 6 in.	12 ft.	1·0 (1·4)	1·1 (6·0)
72 (22)	4 ft. 6 in.	12 ft.	0·1 (0·2)	0·3 (0·4)

Treatments: 0·5 gm. dimefox per hill on May 31, 1957, to all plants; a further 0·25 gm. dimefox per hill on July 19, 1957, to some plants. Data for plants given a second treatment in brackets. 50-gm. sample examined in each case

The results of the leaf analyses are given in Table 1. In each case a representative 50-gm. sample was examined. When dried cones were examined, only 10 gm. was taken.

The figures show that dimefox is rapidly taken up and transmitted to the whole plant until a steady state is reached lasting for several weeks. Increase in the amount of dimefox in the soil brought about by the second application on July 19 showed up about a week later in the upper part of the plant.

Analysis of the ripening cones showed that in the plants which had received only the single application on May 31, 94 days before sampling, the level of dimefox concentration was 0·1 p.p.m. In those plants which had also received the second application on July 19, 44 days before sampling, the level was 0·3 p.p.m.

Harvesting took place in September, 108 and 60 days respectively after the first and second applications. Analysis of samples dried in the commercial manner to about 10 per cent water content showed the level of dimefox to be 0·13 p.p.m. in hop cones from plants which had received the first application only. In the dried cones from plants that received both applications, the concentration of dimefox was 0·33 p.p.m. These values correspond to 0·03 p.p.m. and 0·07 p.p.m. respectively in terms of fresh green material. Such residues would appear to be too low to constitute a health risk.

The results demonstrate the uptake and distribution of dimefox in hops. Many more experiments under different conditions will be necessary before the behaviour of this insecticide is fully understood. It is not at present known whether the dimefox undergoes chemical break-down in the plant or whether it evaporates with the moisture from the leaves. These investigations show that it does not remain as dimefox in the plant tissue.

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Reduction of Parathion induced by Light

WHILE investigating the decomposition of parathion (O,O-diethyl-O-*p*-nitrophenylphosphorothionate) I was able to confirm the findings of Ketelaar[1] on the specific action of Cu^{2+}-ions in catalysing the hydrolysis leading to *p*-nitrophenol. Other metal ions are ineffective, and the catalytic action of copper can be suppressed by various chelating agents[2]. The experiments were carried out at room temperature in a barbiturate milieu at *p*H 8·0 and lasted for more than four weeks. Change in concentration of parathion with a modified polarographic method was followed, and this permitted the estimation of parathion and simultaneously of the *p*-nitrophenol formed. In certain instances however, in solutions not containing the catalyst, a significant decrease of the polarographic wave of parathion was observed though the corresponding appearance of *p*-nitrophenol was not detected. Although in publications dealing with the degradation of parathion[4] there is no allusion to the possibility of a spontaneous reduction, I have shown it to be induced by light.

A 2×10^{-3} *M* solution of parathion (prepared from 20 per cent parathion 'Paridol', Chemisch-Technische Werke A.G. Muttenz-Basel—a material not containing appreciable amounts of degradation products) in 5×10^{-3} *M* *p*H 8·0 barbiturate buffer was divided into several portions and some of them were exposed to direct sunlight. The irradiation was carried out in thin-walled Jena test-tubes. The temperature was controlled continuously and the portions kept in the dark were thermostated according to the temperature of the irradiated specimens. At intervals, samples were taken and analysed by: (*a*) polarography, which gives the amount of non-degraded parathion and any *p*-nitrophenol present; (*b*) the method of Averell–Norris[5], which gives estimates of the intact and reduced parathion; (*c*) the method of Averell–Norris, which was modified for this purpose, omitting the reduction step, thus giving values of the reduced parathion only.

Table 1. DEGRADATION OF PARATHION SOLUTIONS KEPT IN THE DARK AND EXPOSED TO SUNLIGHT

Solution tested	Age of solution	Polarographically		Averell–Norris	
		Parathion	*p*-Nitrophenol	Reduced parathion	Parathion + reduced parathion
		Molarity × 10^4			
'Paridol' alone	2½ hr.				
Dark		20	traces	nil	19
Light		16	traces	5	21
Dark	5½ hr.	20	traces	nil	20
Light		14	traces	7	20
'Paridol' + copper	2½ hr.				
Dark		13·5	6	nil	14
Light		11	7	1·5	14
Dark	5½ hr.	6·5	12·5	nil	7·5
Light		3	13·5	1·9	6
'Paridol' + copper + EDTA	2½ hr.				
Dark		20	traces	nil	23
Light		16	traces	5	21
Dark	5½ hr.	20	traces	nil	24
Light		14	traces	8	22

The solutions contained 0·002 *M* parathion in a 0·05 *M*, *p*H 8·0 barbiturate buffer. Copper ions were applied at a 10^{-4} mol. and ethylenediamine tetraacetate at a 10^{-3} mol. concentration. The results are representative ones, and were obtained on a hot July day in 1957 in Budapest, the temperature of the solutions being 35–45° C.

In parallel experiments I investigated the effect of Cu^{2+}-ions alone and in presence of ethylenediamine tetraacetate. The copper ions, as expected, catalysed the hydrolytic degradation of parathion to *p*-nitrophenol, competing with the light-induced reduction. The chelating agent inhibited the catalytic action.

The results, of which a representative series is given in Table 1, clearly show the photochemical reduction of parathion, presumably to the corresponding *p*-amino-compound. Similar results were obtained by irradiation with a mercury discharge lamp. It is planned to conduct further experiments in order to investigate the effect of *p*H, various other metals and chelating agents, and the behaviour of spray residues under field conditions.

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Gibberellin and the Growth of Plant Tissue Cultures

Two recent publications report the effects of gibberellic acid on the growth of excised plant tissues. Netien[1], working with isolates from the tuber parenchyma of *Helianthus tuberosus*, found a slight increase in growth at 1 p.p.m. in the absence of indolylacetic acid and a decrease at higher levels. In the presence of the auxin all levels of gibberellic acid were quite inhibitory. Schroeder and Spector[2] used explants from the mesocarp of mature citron (*Citrus medica*). They found gibberellic acid, in the absence of indolylacetic acid, caused an increase in weight at 5 p.p.m. In the presence of indolylacetic acid all levels tested resulted in increases in weight.

This report is concerned with the effect of gibberellins on the growth of plant tissues *in vitro* using well-established, actively proliferating clones. The present results are part of a larger report now being prepared. The tissues discussed here were selected to show that an increase in growth, no effect, or a decrease in growth can be obtained under the same conditions by changing the test material.

All the tissues listed in Table 1 have been in culture in this laboratory for the past seven years. The basal synthetic medium used for all tissues consists simply of mineral salts, sucrose, three vitamins, trace elements, and agar[3]. Gibberellin stock solutions were made up at ten times the desired concentration, sterile-filtered through sintered glass, and added to give the desired level to previously autoclaved basal medium just prior to solidification. Experimental transfers of equal size were made to the solid medium and initial weights recorded. After four and eight weeks growth in an air-conditioned culture room at 22·5° C., the tissues were weighed. The results are expressed in Table 1 as 'growth value', which is a number obtained by dividing the final wet weight by the original wet weight. All values are the average of two experiments with five replicates in each experiment.

Table 1. Effect of Gibberellin on Growth of Plant Tissue Cultures on Synthetic Medium

Plant source	Part	Type of tissue	Growth value			
			4 weeks		8 weeks	
			Control	Gibberellin (10 p.p.m.)	Control	Gibberellin (10 p.p.m.)
Helianthus annuus	Petiole	Crown gall	12·8	4·4	49·1	11·0
Vinca rosea	Stem	Crown gall	6·3	2·0	35·4	4·3
Nicotiana tabacum	Stem	Crown gall	3·4	3·8	13·5	15·8
Melilotus officinalis	Stem	Crown gall	2·6	2·9	8·9	14·3
Melilotus officinalis	Root	Callus	2·2	3·1	7·0	15·8

These results are only indicative of the results using 10 p.p.m. of gibberellin. Even at this one level, however, it is apparent that no generalizations can be made concerning the effects on plant tissues *in vitro* since both stimulation and inhibition result according to the test material.

A broader account is now being prepared which takes into consideration such problems as the effects of different levels of the gibberellins, the effects of varying the medium and the importance of the type of tissue used as well as its source.

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Effect of Gibberellic Acid on the Growth of Pea Seedlings when imbibed through the Seed Coat

Stowe and Yamaki[1], in a recent review paper, have listed two hundred and two references relating to the isolation and effects of the gibberellins upon various physiological processes in plants.

Work with these plant-growth substances has, however, been primarily concerned with their effects upon plant growth and development subsequent to germination. It is the purpose of this brief communication to demonstrate that gibberellic acid may produce a typical response when imbibed through the seed coat of the dwarf Telephone pea prior to germination.

Approximately fifty dwarf Telephone pea seeds were planted in each of two small wooden flats filled with sterile vermiculite. The flats were placed over porcelainized germination pans so that added solutions could be retrieved after dripping through the vermiculite. Directly after planting, the vermiculite in one flat was saturated with a solution of 1·0 mgm./l. gibberellic acid. The second flat was supplied with distilled water. The solutions caught in the germination pans were poured back over the respective flats daily until utilized or lost. Plants were grown in the greenhouse under long-day (16 hr.) conditions.

Eleven days after planting, treated and control seeds had germinated and were well above the level of the vermiculite. Treated dwarf pea seedlings were, at this time, approximately six times as tall as the control seedlings. The percentage of germination in both flats was comparable.

Seventeen days after treatment the plants in both flats were harvested. The heights of treated seedlings were significantly greater than the heights of control seedlings. The axillary buds, as well as the main axes of the stems, exhibited markedly increased elongation in treated plants. The stems of the treated seedlings were markedly thin as compared with the controls.

Subsequent experiments have revealed that the response to gibberellic acid described above may also be obtained by allowing dwarf pea seeds to imbibe gibberellic acid solution prior to planting.

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Genetic Effects of Carbon Monoxide, Cyanide and Azide on *Drosophila*

The study of chemical mutagenesis has directed attention to the possibility that the so-called spontaneous gene mutations may in fact result from the accumulation of mutagenic substances arising as a consequence of normal metabolism. In bacteria, the spontaneous mutation-rate of dividing cells may be 40 times greater than that of non-dividing cells[1]. On the other hand, there does not seem to be any simple relation between mutation and cell division itself[2]. This may be interpreted to mean that, as a result of metabolic activity associated with synthesis and growth, chemical mutagens arise and may eventually react with the genetic material. The discovery of 'anti-mutagens'[3] would appear to support this hypothesis. An anti-mutagen might directly mop up traces of the mutagen, or it might initiate further biochemical reactions serving to divert the mutagen into alternative channels.

D'Amato and Hoffman-Ostenhof[4] have recently reviewed the possibility that spontaneous mutation in plants may result from the accumulation of mutagenic by-products of metabolism. The genetic effects of respiratory inhibitors are clearly relevant to the problem. Although some inhibitors might prove to be mutagens in their own right, capable of reacting more or less directly with the genetic material, others might operate simply by disturbing normal metabolic activity in such a manner that an excessive production of natural mutagens results, enabling a greater number of 'spontaneous' mutations to be recorded. Cytogenetic analysis of such mutations would give a picture essentially the same as that obtained from the analysis of spontaneous mutations obtained from untreated material. We should also keep in mind the possibility that any genetic effects of respiratory inhibitors might stem from interference with recovery processes. Wolf and Luippold[5] have found an association between oxida-

tive metabolism and the restitution of radiation-induced breaks in root tip cells of *Vicia*.

Conger and Fairchild[6] reported some years ago that even the simple metabolic experiment of increasing oxygen tension can induce chromosome breaks in *Tradescantia*, suggesting that the oxygen normally present in the air may be responsible for the low spontaneous frequency of aberrations. If the normal rate of oxygen metabolism is exceeded, more genetic damage results.

Inhibitors known to block heavy-metal respiratory enzyme systems have been shown in some cases either to be mutagenic or to be capable of modifying the effectiveness of irradiation treatments[7–13]. In *Drosophila*, injection of cyanide or azide solutions into adult males does not prove to be mutagenic[14]. Nor is carbon monoxide mutagenic when used alone. However, it seemed possible that combined treatment with two inhibitors might prove effective where single treatments had given negative results.

Genetic effects were scored as sex-linked recessive lethals obtained by the usual Muller-5 technique, using Canton *S* males as test material. The incidence of such lethals in untreated males of this stock is about 0·1 per cent for sperm produced within the first few days.

Successive broods were obtained by transferring each male to three fresh females every third day. Both the azide and cyanide were used as 0·005 *M* solutions in 0·7 per cent sodium chloride. In the case of the cyanide, the *p*H was adjusted to 7·0 just prior to injection. The carbon monoxide treatment consisted of exposure of the flies immediately after injection to a gas mixture of 95 per cent carbon monoxide with 5 per cent oxygen at 18° C. for 6 hr. Carbon monoxide alone is not mutagenic under the conditions of testing. However, when supplemented by simultaneous treatment with either cyanide or azide, a mutagenic effect is obtained (Table 1). On the other hand, in the absence of carbon monoxide, cyanide and azide are themselves not mutagenic[14], although together they may elicit a weak response (Table 1).

Table 1. Sex-linked Recessive Lethals obtained from Canton *S* Males

Brood	Carbon monoxide	Azide–carbon monoxide	Potassium cyanide–carbon monoxide	Azide–potassium cyanide
	(per cent)	(per cent)	(per cent)	(per cent)
1	1/545 (0·18)	6/436 (1·38)	3/319 (0·94)	0/374
2	1/496 (0·20)	4/573 (0·70)	2/377 (0·53)	2/449 (0·44)
3	0/407	3/355 (0·84)	1/281 (0·35)	1/412 (0·24)
4	0/284	1/419 (0·24)	1/312 (0·32)	1/390 (0·26)
5	0/178	0/242	0/195	0/211

Combined treatment with carbon monoxide and either cyanide or azide is also mutagenic to spermatozoa stored within the spermathecæ of inseminated females, although in this case the yield of offspring is small owing to the small number of eggs laid by *Drosophila* females after exposure to the gas.

Theories of peroxide formation have been prominent in much of the current work on chemical mutagenesis and a peroxide theory might appear to provide the simplest explanation for the effectiveness of carbon monoxide when supplemented by azide injections. The first inhibitor, by blocking the cytochrome pathway, would direct activity into a flavoprotein respiratory pathway with peroxide as a terminal product. The second inhibitor, by blocking the activity of catalase, would facilitate the accumulation of the peroxide beyond the threshold concentration. However, this simple explanation ignores the fact that cyanide and azide alone are not mutagenic in *Drosophila*, although they are inhibitors of both cytochrome oxidase and catalase. In the case of cyanide, it is possible that the inhibition of catalase is only transitory, for the accumulation of peroxide might well serve to oxidize the cyanide to cyanate and thus relieve the inhibition of the enzyme. On the other hand, cyanide is not to be regarded as a cytochrome oxidase inhibitor with the same degree of specificity as carbon monoxide. Nor for that matter is azide. No doubt both these inhibitors have other important biochemical effects. There is evidence that even carbon monoxide itself may, under certain conditions, serve to stimulate respiration[15], and the mutagenic effectiveness of combined treatments with this inhibitor might find an explanation along these lines.

Hydrogen sulphide is also capable of blocking the activity of both cytochrome oxidase and catalase, but it does not seem to be mutagenic in *Drosophila*. We have found that exposure of males or inseminated females to 1 : 1,000 hydrogen sulphide for 15 min. (approximately *LD*50) fails to increase mutation-rate. Combined treatments with cyanide or azide give weak responses which, however, are not statistically significant. The effect of simultaneous treatment with carbon monoxide and hydrogen sulphide has not been tried.

As hydrogen sulphide is extremely toxic to *Drosophila*, it may not be possible to administer a dose that is mutagenically effective without at the same time achieving a killing action on the cells. Certainly, flies which have been treated with this gas show very poor fertility.

The different mutagenic responses obtained from these various treatments emphasize the complexity of the biochemical mechanisms involved. Interpretation in terms of the simultaneous inhibition of heavy-metal respiratory enzymes is undoubtedly an over-simplification. It is hoped that further work along these lines will be directed towards a cytogenetic analysis, enabling a qualitative comparison to be made between spontaneous mutations recovered from untreated material and those recovered from material receiving combined azide–carbon monoxide treatment.

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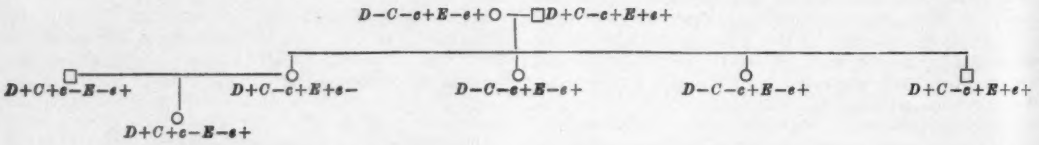
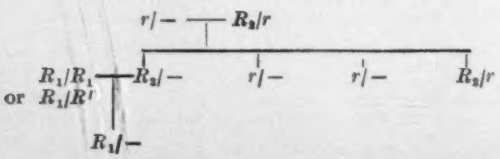
A New 'Deleted' *Rh*-Chromosome

In 1950, Race, Sanger and Selwyn reported[1] a very unusual *Rh* phenotype characterized by an extraordinary strong reaction with anti-D sera and completely negative reaction with anti-C, anti-c, anti-E and anti-e sera. The case was explained as the homozygous form of a partially deleted *Rh* chromosome, designated $D - -$. Since then several examples of this chromosome have been reported, and further other partial deletions have been found[2].

Recently an apparent mother-child exclusion was found in our laboratory. In a legal paternity case the mother was of phenotype $D + C - c + E + e -$, the child of phenotype $D + C + c - E - e +$. The results were checked with a number of different anti-Rh sera both in saline and using papainized cells and the indirect Coombs reaction. The possibility of an error while taking the blood sample was excluded by investigating new samples from the people concerned. The child was born in hospital, but the risk of an interchange of babies in the maternity ward was negligible, as the child was the only premature baby in the ward at that time. However, the ensuing investigation of the family definitely established the kinship of mother and child. The *Rh* types of the family, which were rather surprising, are shown in the following pedigree, + signifying positive and − signifying negative reaction with the corresponding antibodies.



It is seen that there is an apparent exclusion of maternity in the first generation as well as in the second, the *Rh*-negative grandmother having a daughter who appears to be of genotype R_2R_2 or R_2R^r. We knew that the irregularity affected the *Cc* as well as the *Ee* loci, but the really unexpected finding was, of course, that the grandmother was *D*-negative. The most simple explanation is a new, partially deleted chromosome involving $d(d - -)$, or a triple deletion ($- - -$). It is of course impossible to ascertain if d is present or not, as long as anti-d is not available. It is further obvious that one of the criteria on the hitherto known partial *Rh*-deletions, the enhanced agglutinability of the *D*-receptor, cannot be put to use in the diagnosis of $d - -$ or $- - -$. However, it is to be expected that the erythrocytes from persons carrying the abnormal chromosome would show single-dose reactivity with regard to the *Rh* receptors, which according to the phenotype appear to be homozygous. Titration experiments against the pertinent sera appear to substantiate this expectation. According to these experiments the genotypes of the family are the following, − denoting chromosome $d - -$ or $- - -$:



A detailed report on the case and the results will be published later. I wish to thank Dr. A. E. Mourant and Dr. D. Parkin, of the Blood Group Reference Laboratory, Lister Institute, London, who kindly checked the results.

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Mitosis and Chromosome Numbers in the Euglenineae (Flagellata)

Nuclear division and the associated division of the cell and cell organelles have been examined in thirty-two species of the Euglenineae, drawn from thirteen genera. The main findings on the structure and mechanics of mitosis in this group are as follows.

Nuclear division in the Euglenineae is a true mitosis in that :

(1) Individualized chromosomes duplicate themselves longitudinally.

(2) Sister chromatids segregate to opposite poles.

The mitosis differs from the 'classical' form in the following ways :

(1) An achromatic body in the nucleus, the 'endosome', persists throughout mitosis, dividing as a structure distinct from the chromosomes (Fig. 1).

(2) The endosome retains its ribonucleic acid during mitosis.

(3) There are no centromeres or spindle.

(4) Mitosis and cell activity are unaffected by 4 per cent colchicine, or by ionizing radiations at doses of up to 100,000 r.

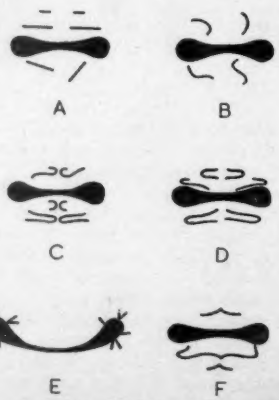

Fig. 1. Chromatid shapes during mitotic anaphase in the Euglenineae. The dividing endosome is also shown

(5) There is no evidence for the presence of centrioles or centrosomes during mitosis. The basal granules of the flagella do not act as division centres.

(6) The chromatin threads become arranged parallel to the division axis at 'metaphase'; in some species the threads are segregating chromatids still associated at one end (Fig. 1, *F*), in others they are chromosomes which become duplicate in their parallel position and segregate in anaphase.

(7) Separation of chromatids is staggered in some species.

(8) There are four main chromatid shapes during anaphase movement: straight rods (Fig. 1, *A*); curving threads (Fig. 1, *B*); U-shapes towards the division equator (Fig. 1, *C*); and U-shapes towards the poles (Fig. 1, *D*). Rods and V-shapes radiating from the ends of the dividing endosome occur in a few species (Fig. 1, *E*).

(9) Anaphase movement of the chromatids is staggered.

(10) The nuclear membrane persists throughout mitosis.

(11) The mitosis lasts 2–4 hr., anaphase occupying 35–86 min. in different species, as compared with 1–20 min. in all other organisms and tissues for which records exist.

(12) The absolute velocity of the chromatids separating at anaphase is less than 0·1μ per min. at 20° C., compared with 0·3–6·0μ per min. for all other recorded material.

In the light of the above evidence, and in the absence of centrioles, centrosomes, true blepharoplasts, centromeres, and spindle, it is suggested that chromatid movement in the Euglenineae is autonomous—a mutual repulsion by sister chromatids to opposite poles. The dense nucleoplasm and the retention of the nuclear membrane during mitosis prevents a scattering of chromatids in the cell. The nuclear membrane is stretched by the two groups of repelling chromatids and separation to two cytologically and genetically equivalent nuclei finally occurs.

A further feature of euglenoid mitosis is the general occurrence of high chromosome numbers. Chromosome counts have rarely been attempted in the Euglenineae. Pringsheim[1] says, "The number of chromosomes has not been established in any case, owing no doubt to difficulty caused by their number, length and dense accumulation. This is to be regretted, because polyploidy may be expected in certain groups".

I have made counts for six species, and estimates for a further eight (Table 1). In most species the clearest counts are obtained in anaphase or telophase.

Table 1. Chromosome Numbers in the Euglenineae

Counts		Estimates	
Euglena spirogyra	86	*Astasia klebsii*	18
Euglena viridis	42	*Colacium mucronatum*	35
Eutreptia lanowii	90	*Euglena gracilis*	45
Eutreptia viridis	44	*Lepocinclis ovum* var. *buetschlii*	84
Hyalophacus ocellatus	92	*Menoidium cultellus*	15
Phacus pusillus	42	*Peranema trichophorum*	177
		Trachelomonas bulla	25
		Trachelomonas grandis	40–60

The only direct comparisons with records by previous workers are my estimate of 45 for *Euglena gracilis* and a count of 14 by Baker[2], and my estimate of 177 for *Peranema trichophorum* and counts of 6 (!) by Hartmann and Chagas[3] and 32 by Brown[4]. The low counts by these authors were probably caused by fusion of the separate elements in poorly fixed material. The counts of 44 for *Eutreptia viridis* and 90 for *Eutreptia lanowii* indicate possibly polyploidy in this genus.

A full account of this work will be published elsewhere. The study was carried out in the Department of Botany, Queen Mary College, London, and will be continued at the Durham Colleges in the University of Durham. I would like to acknowledge the help and advice of Dr. M. B. E. Godward of Queen Mary College, and of Prof. E. G. Pringsheim of the University of Göttingen.

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Number of Mating Types required for Balance in Multipoint Linkage Programmes

In two-point linkage work it is advantageous to use coupling and repulsion back-crosses in approximately equal numbers, for, with equal numbers of progeny, disturbances due to differential viability need not affect the estimation of the recombination fraction between the two loci. In fact, it is only possible to allow for differential viability in all the segregating phenotypes by this method of 'balance', and it may be shown that the estimation of the recombination fraction is most efficient when the balance is exact. The minimum requirement for balance is that the numbers of progeny from the coupling and repulsion back-crosses must be equal; in other contexts the definition of balance may be narrower, but it is used here as defined by this minimum requirement. This idea is just as fruitful in multi-point linkage work, but it is not necessary to make up matings using all the possible genotypes of multiple heterozygotes in order to ensure a set balanced for all pairs of loci. The present problem is to determine the minimum number of mating types needed for making up a balanced set for any given number of loci.

With two loci we may represent the heterozygote in coupling by + +, and the heterozygote in repulsion by + −. The symbols indicate that in the coupling heterozygote both wild-type genes are on the same chromosome, while in the repulsion heterozygote they are on different chromosomes. The existence of either coupling or repulsion may be inferred from these symbols by multiplying them together. Thus + × + = + (coupling), and + × − = − (repulsion). The set is said to be balanced when there are equal numbers of coupling and repulsion mating types; that is, when there are equal numbers of + and − signs resulting from this multiplication procedure. If, instead of just + and −, we use + 1 and − 1, then the set will be balanced when the sum of the products of the two numbers representing each mating type is zero.

This procedure may be simplified for more than two loci by using a matrix notation. In the example above, we write the symbols for the two mating types one under the other:

$$\begin{matrix} 1 & 1 \\ 1 & -1 \end{matrix}$$

Calling this the matrix a, and its transpose (which is in this case its identity) a^*, the condition for balance is:

$$a^*.a = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix} = 2I$$

This is just a convenient way of recording the fact that 'the numbers in any two columns, taken in pairs and multiplied together, sum to zero'. In this example there are only two columns, that is, one pair, but with four loci there are four columns, and so six pairs, one for each pair of loci.

The full solution of the problem is equivalent to the solution of the matrix equation $a^*.a = qI$, where a has p columns and q rows, p being the number of loci, and q the number of mating types in the balanced set.

Mr. S. Wylie, of Trinity Hall, Cambridge, who introduced the matrix notation to this problem, has pointed out that the enumeration of these matrices is equivalent to the enumeration of anallagmatic pavements. An anallagmatic pavement is a square pavement of black and white tiles so arranged that when any two columns or any two rows are placed together side by side, half the tiles next to one another are of the same colour and half are of different colours.

We are only concerned with square matrices, for it is clear that if a set is balanced for p loci, it is also balanced for $p - 1$ loci, and it may be proved, by *reductio ad absurdum*, that there does not exist a balanced set of p mating types for $p + 1$ loci.

A $p \times p$ pavement does not exist for $p > 2$ unless p is a multiple of 4, and it is conjectured[1] that it does exist when p is a multiple of 4. The first doubtful case is $p = 92$, and this is far beyond the range of genetic interest. It is known that pavements exist whenever p is divisible by 4 and of the form $2^k(s^n + 1)$, where s is an odd prime, and k and n are integers. 92 is the lowest multiple of 4 which is not of this form.

Thus we are able to draw up a table of number of loci and the corresponding minimum number of mating types in a balanced set :

Loci	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Mating types	2	4	4	8	8	8	8	12	12	12	12	16	16	16	16,	etc.

The enumeration of these pavements for $p > 4$ presents a formidable problem. Two 'basic' pavements are set out below for 8 loci, and many more may be derived from each by the interchange of columns, etc.

+	+	+	+	+	+	+	+
−	+	−	+	−	+	−	+
−	−	+	+	−	−	+	+
+	−	−	+	+	−	−	+
−	−	−	−	+	+	+	+
+	−	+	−	−	+	−	+
+	+	−	−	−	−	+	+
−	+	+	−	+	−	−	+

+	+	+	+	+	+	+	+
+	−	−	−	+	−	+	+
+	+	−	−	−	+	−	+
−	+	+	−	−	−	+	+
+	−	+	−	+	+	−	+
−	+	−	+	+	−	−	+
−	−	+	−	−	+	+	+
−	−	−	+	−	+	+	+

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Chromosome Breakage in *Vicia faba* by Ozone

Important to an understanding of the biological effects of high-energy radiations is the concept of active radical formation in water[1]. The inability of hydrogen peroxide *per se* to simulate irradiation effects at concentrations expected in the cytoplasm of irradiated cells[2] has focused attention on the active radicals OH and HO_2. The chemical activity of such free radicals produced by the catalytic decomposition of hydrogen peroxide with ferric ions has recently been discussed[3], and Phillips[4] describes the production of chromosome aberrations in barley by these hydrogen peroxide 'precursors'.

The decomposition of ozone in solution produces these same active radicals of interest[5]. From studies of the kinetics and mechanisms of ozone decomposition, Alder and Hill[6] assume that in solution the reactions :

$$HO_3^+ + OH^- \rightleftarrows 2HO_2 \quad (1)$$

$$O_3 + HO_2^- \longrightarrow OH + 2O_2 \quad (2)$$

are responsible for disappearance of ozone and are relatively slow and determine the rate of reaction; also, these authors indicate that reaction (1) represents an equilibrium which is maintained so long as ozone is present. The decomposition of ozone in solution is catalysed by hydroxyl ions and dependent upon temperature[7].

In these investigations, root meristem cells of *Vicia faba* were exposed to an atmosphere of ozone and the fraction of cells showing chromosome aberrations (as anaphase bridges) were recorded. The cells were all exposed in interphase and analysed at the first anaphase.

Fig. 1 is a schematic diagram of the apparatus used for challenging the seeds. The ozone was produced from cylinder oxygen and the concentration calculated by scrubbing replicate samples of known volume through 2 per cent potassium iodide (*p*H 9·0), the solution acidified and then titrated with 0·1 *N* sodium thiosulphate. With a flow of 2 l./min., 0·4 weight per cent ozone was present. The cold trap was found to be unnecessary and was abandoned. Seed coats were removed from imbibed *Vicia* seeds which were challenged with the ozone–oxygen mixture in the mixing chamber. Batches of seeds were removed after specific intervals, placed in sterile moistened vermiculite, at 19° C. and in the dark, until the radicles were about 2 cm. in length. At this time the first cell divisions occur[8], and Feulgen-stained squash preparations were made.

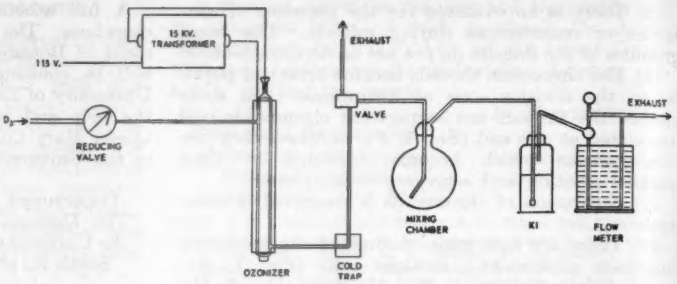

Fig. 1

Table 1 presents the results of exposing *Vicia faba* seeds to 0·4 weight per cent ozone for 15, 30 and 60 min. The term 'abnormal anaphase' is used because no attempt was made to count the number of chromosome bridges per cell; thus an abnormal anaphase may contain one or more bridges. All the bridges observed were of the chromosome-type; that is, they were the result of dicentric or centric ring aberrations. There were neither chromatid-type

Table 1

Experimental group	Percentage abnormal anaphases		
	15 min.	30 min.	60 min.
O_2	0	0	0
$O_3 + O_2$	10	29	42

figures nor sticky bridges, and all the deletions were double. There was good agreement between root tips in a particular experimental group; for example, in the 60-min. contact group seven root tips were used for obtaining about 500 anaphase figures analysed, with a mean value of abnormal anaphases of $42 \pm 1{\cdot}6$ per cent per slide.

Table 2 presents the results of ozone, X-rays, and ozone and X-ray treatments. 150 kV., 15 m.amp. unfiltered radiation was delivered at 50 r./min. as determined by an ionization meter. When the X-rays and ozone were combined, the oxone was administered first and the X-rays immediately after, so that the entire treatment required less than 25 min. The effects of ozone and X-rays were approximately additive.

Table 2

Experimental group	Dose	Percentage abnormal anaphass
O_2	60 min.	0
$O_3 + O_2$	30 min.	23
X-rays	100 r.	25
O_3 + X-rays	20 min. + 100r.	42

A small number of root tips from each group was treated with colchicine and an analysis made of metaphase aberrations. These observations confirmed that the aberrations were all of the chromosome-type (dicentrics and centric rings).

A more detailed report of this work will be published later. These investigations were supported by grant No. *R.G.* 4722 of the National Institutes of Health, U.S.A.

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Use of Defoliants for drying Buckwheat in the Field, and a New Method for the Chemical Determination of Rutin

DEFOLIANTS are commonly used to facilitate the harvesting of cotton[1], beans, clover[2] and birdsfoot trefoil[3] for seeds, or for destroying the haulms of potatoes[4] to inhibit the spread of virus from infected leaves into the tubers. We thought it worth while to examine whether defoliants could be used for drying buckwheat (*Fagopyrum sagittatum* Gilib.), cultivated as medicinal plants, directly in the field, so as to avoid the tedious operations in connexion with artificial drying of the harvested material. As we expected that the rutin content might be influenced by defoliants, we have determined the rutin content of treated plants as compared with the control plants, cut and afterwards dried.

Table 1

Treatment	Rutin (per cent)	Quercetin (per cent)
Artificially dried plants	4·04	none
Sprayed with water alone and dried	3·62	0·10
0·1 per cent of sodium chlorate spray	3·60	0·18
1·0 per cent of sodium chlorate spray	2·68	0·24
2·0 per cent of sodium chlorate spray	2·30	0·27
1 per cent dinitrocresol (sodium salt) spray	2·20	none
10 per cent pentachlorophenol (sodium salt)	2·40	0·16

Buckwheat in full blossom was sprayed with several defoliants (see Table 1). Within five days 1 per cent sodium chlorate solution produced the most suitable drying of leaves, stalks and flowers among other defoliants used. Dried leaves were collected in a perfectly dehydrated form, leaving the empty stalks on the field (Fig. 1). The rutin content of the stalks, which is highest at the stage of bud formation and during that of flowering, is relatively small compared with that of the leaves[5].

The rutin content of the leaves was determined chemically. A new method was developed for this purpose, based on the colour reaction[6] of rutin with diazonium salts after its chromatographic separation[7]. 2·5 gm. of fresh leaves of buckwheat (or 0·25 gm. of dried material) is extracted in a Soxhlet apparatus for 90 min. with methanol (4 per cent pyridine was added when working with dried material) to determine

Fig. 1. Buckwheat five days after being sprayed with 1·0 per cent sodium chlorate solution and harvested (in front) and unsprayed (in background)

approximately the total flavonoids (phenolic compounds). An aliquot part (about 1 per cent) of the extract is evaporated to dryness, the rest dissolved in hydrochloric acid, a solution of diazotized sulphanilic acid is added and made alkaline with sodium hydroxide solution. The extinction is measured photometrically after 45 min. using a green filter (5330 A.), and the total flavonoids calculated from the graph for pure rutin.

A suitable quantity of the extract containing 200–300 μgm. of rutin (about 50–60 per cent of the total flavonoids) is chromatographed on Whatman No. 4 paper with 60 per cent aqueous acetic acid. The rutin spots are eluted with 0·1 *N* hydrochloric acid after detection in ultra-violet light and evaluated photometrically in the same manner as the total flavonoids. The quercetin content is estimated by comparison of the intensity of its yellow fluorescence in ultra-violet light with that of a progressive row of standard quercetin solutions chromatographed on the same paper.

We intend to investigate the effect of defoliation on other medicinal plants used not as drugs but as raw material in the pharmaceutical industry. A full account of this work will be published elsewhere.

Note added in proof. The leaves of buckwheat do not remain on the plants if they are not harvested within about seven days after treatment (depending on the weather), but it is hoped that the saving of labour and expense due to the use of this method compared with artificial drying may outweigh this disadvantage.

Recent experiments with defoliation of peppermint show a slow reduction of oil-content (from 1·53 per cent to 1·25 per cent—this difference being highly significant), but the leaves of peppermint plants remain on the stalks, in contrast to the behaviour of buckwheat.

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Spot Chromatography Identification of Citrus Rootstocks

The importance of knowing the variety of the rootstock in a citrus orchard is more than academic. The tolerance of an orange tree to infectious diseases; the size, the number and quality of its fruits; the palatability of its fresh and processed juice; its rate of growth and its expected longevity are all dynamically affected by the rootstock on which it is growing. Many of the citrus trees in California and elsewhere are growing on rootstocks the identity of which is not definitely known.

Methods for the chemical identification of citrus rootstocks have been published[1,2], and a paper chromatographic test for sour orange roots has been described[3,4].

This communication deals with a new method for the identification of the eight varieties of citrus rootstocks that are used commercially in California. The eight varieties are: sour orange (*Citrus aurantium* 'Brazilian'); grapefruit (*C. paradisi* 'Duncan'); sweet orange (*C. sinensis* 'Koethen'), tangelo 'Sampson', a hybrid of the tangerine 'Dancy' and grapefruit; mandarin (*C. reticulata* 'Cleopatra'); rough lemon (*C. limon*, considered by some to be a hybrid); trifoliate orange (*Poncirus trifoliata*); and 'Troyer' citrange, a bigeneric hybrid between navel orange (*C. sinensis*) and the trifoliate orange (*P. trifoliata*).

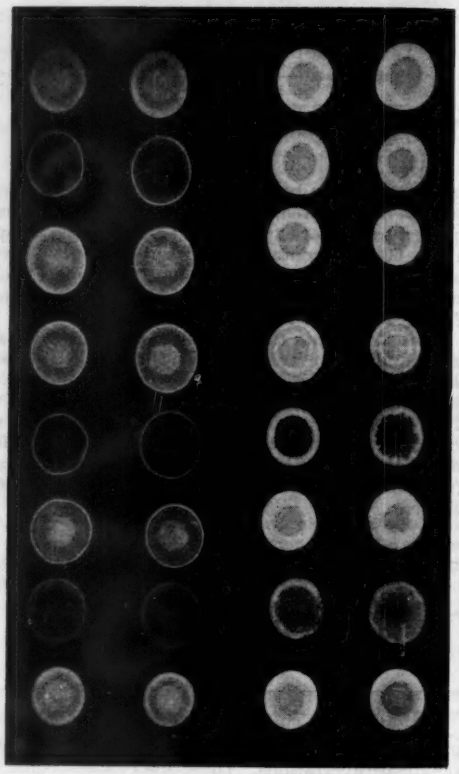

Fig. 1. The two lef -hand columns of spots are those made by dropping single drops of a plain 30-min. dimethoxypropane extraction of each root. The two right-hand columns of spots are from the 30-min. extractions to which anhydrous aluminium chloride was added and allowed to react for 30 min., before the spot was made. *a*, Sour orange (Brazilian); *b*, grapefruit (Duncan); *c*, sweet orange (Koethen); *d*, tangelo (Sampson); *e*, mandarin (Cleopatra); *f*, rough lemon; *g*, trifoliate; *h* citrange (Troyer)

The roots used were obtained from the experimental Valencia orange orchard of the University of California at Riverside, California, through the courtesy of Dr. W. P. Bitters. Each rootstock had been propagated by 'nucellar' seedlings. All the trees were thirty years old except for the Troyer citranges that were planted in 1944.

The method described here compares the spots made on filter paper by drops of extracts of unknown roots with similar spots made from known varieties. Under long-wave ultra-violet light (3650 A.) the spots fluoresce and display distinctive concentric yellow, brown and green circles. Fig. 1 indicates in black and white some of the distinguishing differences.

Of the thirty-three solvents tested, dimethoxypropane was the most satisfactory when used as

described in (1) below. Complete identification of all of the rootstocks was not attained by using dimethoxypropane alone; so the extractions were subjected to reactions with salts of heavy metals. Of the thirty-six salts tried, anhydrous aluminium chloride, when used with dimethoxypropane, was the best. See (2) below.

(1) Freshly dug roots, $\frac{3}{8}$ in. diam. and larger, are washed free of dirt and wiped dry. The bark is cut through to the cambium and into pieces $\frac{1}{4}$ in. square and smaller. 10 gm. of the fresh bark are placed in a bottle. 15 ml. of 2,2-dimethoxypropane 98 per cent (Dow Chemical Co.) are added, and the mixture is allowed to stand for 30 min. at room temperature. Then single drops of the extraction are placed with a medicine dropper on a sheet of Whatman No. 1 filter paper. It will be noticed in Fig. 1 that the two left-hand vertical columns of spots represent the 30-min. extractions of the eight varieties of rootstocks. The two right-hand columns of spots were made by following the procedure described in the next paragraph.

(2) Arrange a series of clean, dry, 10 mm. × 75 mm. test-tubes, one tube for each rootstock. In each tube place 0·1 gm. of anhydrous aluminium chloride. This should be done ahead of time so that, immediately following step (1), 1·5 ml. of each of the 30-min. extractions may be added separately to 0·1 gm. of the aluminium chloride. Shake the tubes and allow them to stand for 30 min. At the end of that time single drops of the supernatant fluid in each test-tube are placed on the filter paper in the two right-hand columns. The spots should be allowed to dry thoroughly before comparisons are made between the known and unknown varieties.

The spots tend to deteriorate in a day or two. Precautions should be taken to prevent the spots on one sheet from spoiling those on other sheets which may be piled on top or below by inserting each sheet between a folded piece of wax-paper.

Unused roots may be kept for 2 or 3 days in plastic bags in a refrigerator at 4° C. or less. One batch of roots was kept in a food freezer at 0° C. for 34 months. The fluorescent spots of all of the varieties were within the usual range of colours except for the sweet rootstocks.

I wish to express my thanks to Dr. W. P. Bitters, Mr. Robert Hepler and Mr. James L. Jones.

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Perceptual Stability of a Stroboscopically Lit Visual Field containing Self-Luminous Objects

IT is a familiar observation that when the retinal image is displaced as a result of an externally forced rotation of the eyeball (for example, by light sideways pressure with the finger), the visual world appears to move; whereas when the same rotation is produced voluntarily the visual world remains stable. This stability is often attributed to some (as yet unknown) process by which the effects of retinal change are thought to be accurately compensated or cancelled out during voluntary movement.

In the course of experiments designed to explore a different hypothesis[1], a rather striking phenomenon has been observed. If a room containing self-luminous objects (such as the cathodes of thermionic valves) is lit stroboscopically, it is found that at rates of flash down to some 15 per sec. the effects of pressing the eyeball intermittently (say, twice per sec.) and very lightly, are similar to those in ordinary light. At rates of some 5 or 6 per sec., however, a remarkable disparity is observed between the apparent motion of the self-luminous objects and that of the rest of the room. The glowing cathode of a valve, for example, appears to move whereas its envelope remains at rest, although surprisingly enough their relative positions can be clearly seen to be unaltered. A similar violent perceptual disturbance occurs with an artificial nystagmus, induced, for example, by first rotating the observer rapidly about a vertical axis with his eyes closed. The effect seems insensitive to level of illumination over the range used (0·3–3 Joules per flash), and has been described in similar terms by all of some fifty observers to date. To by-pass speculations invoking distortion of the eyeball, it may be said that the same disturbance occurs when the retinal image is displaced by moving a prism or mirror before the eye.

The apparent movement of the self-luminous objects would seem to be interpretable as the normal result of involuntary displacement of their retinal image, since that image is thrown continuously upon the retina. What is at first sight surprising (especially on any theory of 'compensation') is the relative stability of the stroboscopically lit room. It seems clear that a discontinuous displacement of the retinal image is not so powerful a stimulus for the perception of world-movement as when continuous motion produces the same displacement. If the eyeball is lightly pressed and held in its new position, the stroboscopically lit field is seen to move sluggishly to 'catch up' with the self-luminous objects, requiring several flashes to do so. The interesting conclusion suggested is that the magnitude of perceived movement is a function of the amount of information (in the technical sense) supplied by the retinal image, rather than of the magnitude of its displacement.

Two related observations seem to support this tentative conclusion. First, even in normal light the motion perceived during involuntary rotation of the eyeball seems to most observers to be greater in the central than in the peripheral parts of the field. This again suggests that the greater density of foveal information is transformed into a greater magnitude of perceived motion. Secondly, when a retinal image of radial lines (such as my 'ray' figure[2]) is involuntarily displaced, the normal apparent movement of the centre is accompanied by a fanwise movement of the rays lying nearest to the line of motion. The pattern appears to open out, as if on a distended rubber sheet, on the side away from which the centre moves, and to contract on the opposite side. The effect is suppressed if a line is drawn across the pattern at right angles to the rays concerned. The suggested inference is again that the magnitude of motion perceived is greater in those directions in which more information is generated by the retinal displacement.

The foregoing observations afford some encouraging confirmation of the hypothesis I have put forward[1]—this having, for once, had the good fortune to be advanced ahead of them on theoretical grounds. Briefly, the argument is that if perception is the

adaptive 'keeping up to date' of an organism's state of organization for activity in its world[3], then what requires informational justification is not the maintenance of stability but the perception of change. The internal state of organization, which implicitly represents the perceived world, should remain unaltered unless sufficient information (in the technical sense) arrives to justify a change, by indicating that the current state of organization is significantly mismatched to the state of affairs sampled by the receptor system[4].

Thus the retinal changes resulting from voluntary movement evoke no perception of world-motion, because they are not an awkward consequence to be compensated, but part of the goal to be achieved. If these changes are prevented from occurring, for example by stabilizing the retinal image, the absence of retinal change evokes an impression of movement.

From this point of view, all the anomalies reported above make some sense as evidence that: (*a*) perceptive activity is relatively detached from that of the receptor system; (*b*) in sampling the receptor field, the perceptive system is relatively insensitive to the position of the image, and demands a combination of evidence exceeding some 'threshold of significance' before it responds by the perception of a change; (*c*) the strength of the impression of change depends on the total amount of information validating a change in the state of organization—in other words, it depends on the informational weight attached to discrepant samples from the receptor system; (*d*) the change perceived, however surprising to the observer, is always the most parsimonious which will match the discrepant information; perception would appear to be organized on the conservative principle of a null-hypothesis.

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Dec. 19.

[1] MacKay, D. M., "Some Perceptual Problems in Terms of Information-Flow": paper read at the Cambridge Conference on Thinking, 1955. A development of the theory was presented at the 15th International Congress of Psychology, August 1957, under the title "The Stability of the Visual World during Voluntary Activity", and will be published shortly.
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Sub-aerial Volcanicity in Snowdonia

Extensive recent work in south-central Lleyn (F. J. F.), Beddgelert (N. R.) and the pass of Llanberis (F. J. F. and N. R.), supplemented by observations from the pass of Aberglaslyn (R. V. B.) warrants a new interpretation of Snowdonian volcanics of mid-Ordovician age.

It appears now that the acid volcanics of Snowdonia exhibit many phenomena found in areas where recent volcanicity has been in progress (for example, New Zealand, Alaska). Four main features of Snowdonian volcanics are worthy of emphasis. (1) The bulk of the volcanics consist of ignimbrites or welded tuffs. A wide variety of these rocks are found ranging from fine dusty varieties (National Grid No. $SH_{(2)}576_{(3)}509$) to coarse welded agglomerates ($SH_{(2)}632_{(3)}563$). The general absence of bedding and the widespread presence of flattened vesicles in these rocks is suggestive of sub-aerial rather than submarine deposition of the glowing avalanches. Frequent vertical explosive shoots and tuff pipes traversing the ignimbrites are now recognized (for example, $SH_{(2)}593_{(3)}525$). The tuff pipes are probably produced by fumarolic action similar to that recorded from the Valley of Ten Thousands Smokes, Alaska.

(2) In many cases extrusion of basic lavas preceded the deposition of welded tuffs. Well-preserved top surfaces of ropy lava have been found suggesting that the top of the flow was sub-aerial. Since these lavas are often blocky or even pillowy at their lower boundary, where they are often mixed with muddy sediments, a transition from sub-marine to sub-aerial conditions must have taken place during their extrusion. The basic lavas have been mapped by H. Williams[1] as deformed dolerites.

(3) The acid deposits often contain rocks previously called 'the nodular rhyolites'. There are several varieties of 'nodular rhyolites', each originating in a different way. For example, some of the so-called 'nodular rhyolites' near Beddgelert are spherical bodies of medium grain welded tuff in a matrix of a fine grain welded tuff.

(4) Near Pont y Gromlech in the pass of Llanberis a volcanic centre has been recently identified. West of Pont y Gromlech a vent of agglomerate ($SH_{(2)}623_{(3)}565$) traverses the grits and slates of the Gwastadnant Group terminating in the Lower Rhyolite Tuff. Hereabouts, the main volcanic sequence is underlain by deposits consisting of large boulders of grit, slate and volcanic material in muddy or silicified matrix. These deposits seem to represent mud-flows (lahars), which preceded the main Snowdonian ignimbrites.

The presence of welded tuffs in Snowdonia was first recorded by Oliver[2], who identified as such a thin section from Capel Curig. Our work suggests that the bulk of Snowdonian acid volcanics are welded tuffs with subsidiary basic lavas. If so, then the thickness of such deposits has no direct bearing on the proximity to the volcanic centres, since the modern welded tuffs are known to thicken in the pre-existing topographic hollows (for example, see Enlows[3]). That the main Snowdonian ignimbrites were deposited on an irregular surface possessing such hollows has been now proved by detailed mapping of the well-exposed lower boundary of the Lower Rhyolite Tuff near the Pen-y-pass Hotel, Pass of Llanberis.

In so far as their mode of extrusion is concerned, accumulating evidence suggests that the Snowdonian volcanics were derived from numerous small sub-aerial explosive vents, such as have been recognized in the Pass of Llanberis and in Lleyn. These vents are associated with intrusive rhyolites but, contrary to Matley's[4] opinion, not with granophyre or micro-granite intrusions.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 17

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. A. Stephenson: "Surveying and the Modern Expedition".

ROYAL INSTITUTION, LIBRARY CIRCLE (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. S. Rees Jones: "The Painter's Eye—a Talk on Science and Painting".

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street, London, W.C.1), at 5.45 p.m.—Dr. J. A. Kitching: "Physiological Mechanisms in the Protozoa".* (Further lectures on February 19 and 21.)

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP and CORROSION GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Mr. R. J. Coursbee: "Corrosion of Spraying and Dusting Machinery".

BRITISH COMPUTER SOCIETY (at York Hall, Caxton Hall, Westminster, London, S.W.1), at 6.15 p.m.—Prof. A. C. Aitken: "Mental Arithmetic, an Historical Review with Demonstrations".

INSTITUTE of METAL FINISHING (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. A. R. Thompson: "Health Hazards Associated with Metals Affecting the Finisher".

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.30 p.m.—Mr. W. C. Botfield: "Perfumery".

Tuesday, February 18

BEDFORD COLLEGE (at Regent's Park, London, N.W.1), at 5.15 p.m.—Dr. W. Grey Walter: "The Physiology of Mentality".*

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. C. A. G. Wiersma (California Institute of Technology): "Comparative Physiology of Crustacean Neuro-Muscular Systems".*

IMPERIAL COLLEGE (in the Main Chemistry Lecture Theatre, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. F. D. Richardson: "The Changing World of the Extraction Metallurgist" (Inaugural Lecture).

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. E. Flood: "Electronic Devices in Telephony".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. H. C. Husband: "Jodrell Bank Radio Telescope".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. C. D. Mee: "Magnetic Tape for Data Recording".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Meeting on "Solid Source Mass Spectrometry".

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. F. Schollick: "Some Aspects of Amino Coating Resins".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. E. G. Broadbent: "Aeroelastic Problems associated with High Speeds and High Temperature".

WOOL EDUCATION SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 7 p.m.—Mr. H. B. Carter: "Science and the Wool Grower".

BRITISH GLACIOLOGICAL SOCIETY (joint meeting with the CHALLENGER SOCIETY, at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Dr. Erkki Palosuo: "Sea Ice Prediction Techniques in the Baltic".

Wednesday, February 19

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. J. E. P. Dunning: "Rocket Propulsion".

EUGENICS SOCIETY (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Prof. Aubrey Lewis: "Fertility and Mental Disorder"* (Galton Lecture).

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. G. A. Corby and Mr. J. A. Sawyer: "The Air Flow Over a Ridge—the Effects of the Upper Boundary and High-level"; Mr. C. E. Wallington and Mr. J. Portnall: "A Numerical Study of the Wave-length and Amplitude of Lee Waves".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. M. G. Kendall: "Research in Statistics".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Sir Christopher Hinton, F.R.S.: "Nuclear Power Development—Some Experiences of the First Ten Years"* (Melchett Lecture for 1957).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. L. C. Jeaty: "The Relation Between Picture Size, Viewing Distance and Picture Quality with special reference to Colour Television and to Spot Wobble Techniques".

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 6 p.m.—Annual General Meeting, followed by Dr. A. H. Willbourn: "High Polymer Properties and Structure".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Scientific Papers.

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6.30 p.m.—Prof. Arne Tiselius, For.Mem.R.S. (University of Uppsala): "Purity and Purification of Chemical Substances" (First Humphry Davy Lecture).

SOCIETY FOR ANALYTICAL CHEMISTRY, BIOLOGICAL METHODS GROUP (in the restaurant room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion Meeting on "The Stage at which a Biological Assay Can be Replaced", introduced by Mr. W. L. M. Perry.

Thursday, February 20

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. R. E. Peierls, F.R.S., Dr. D. H. Wilkinson, F.R.S., and Prof. W. E. Burcham, F.R.S.: "Recent Advances in Nuclear Physics".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—General Meeting.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. W. Milnor: "Groups Which Act on S^n Without Fixed Points".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Mr. J. H. Welch: "Direct Observation of High-Temperature Processes with the Microscope".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. B. S. Platt: "Malnutrition and Pathogenesis of Zymotic Diseases".

Friday, February 21

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 1 p.m.—Dr. N. H. Mackworth: "The Television Eye-marker" (Chairman's Address).

INSTITUTE OF PHYSICS, APPLIED SPECTROSCOPY GROUP (at 47 Belgrave Square, London, S.W.1), at 3 p.m.—Meeting on "X-Ray Fluorescence".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "The Transition from the Ionosphere to Interplanetary Space". Chairman: Mr. J. A. Ratcliffe, F.R.S. Speakers: Prof. Sydney Chapman, F.R.S., Dr. D. E. Blackwell, Dr. J. V. Evans and Dr. A. Hewish.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5.15 p.m.—Air Commodore R. T. Gething, O.B.E., A.F.C.: "Air Search and Rescue Problems".

BRITISH INSTITUTE OF RADIOLOGY, incorporated with the Röntgen Society (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 5.30 p.m.—Papers on "Recent British Gamma Ray Beam Units". Speakers: Mr. T. Ashton, Mr. G. S. Innes, Mr. R. G. Wood, Dr. J. R. Clarkson and Mr. J. C. Jones.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, (in the Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. D. Firth: "The History and Development of Hydraulic Transmissions for Marine Propulsion".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Alexander Haddow: "Cancer Research—Its History and Prospects".

Saturday, February 22

ASSOCIATION OF CLINICAL BIOCHEMISTS, SOUTHERN REGION (at King's College Hospital Medical School, Denmark Hill, London, S.E.5), at 2 p.m.—Scientific Papers. 4.15 p.m.—Demonstrations by Staff of the Department of Chemical Pathology, King's College Hospital.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL LECTURER (with high qualifications in physiology and preferably some experience as a university lecturer) IN ANATOMY AND PHYSIOLOGY—The Principal, Loughborough Training College, Loughborough (February 21).

ASSISTANT LECTURER or LECTURER IN APPLIED MATHEMATICS—The Secretary, The University, Exeter (February 22).

SCIENTIFIC OFFICER (with an honours degree in zoology) IN THE NEMATOLOGY DEPARTMENT—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (February 22).

ASSISTANT LECTURER IN ORGANIC CHEMISTRY; an ASSISTANT LECTURER IN PURE or APPLIED MATHEMATICS; and an ASSISTANT LECTURER IN PHYSICS—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8 (February 28).

ASSISTANT LECTURERS (2) (honours graduates, with some research experience in physical, inorganic or physical-organic chemistry) IN CHEMISTRY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (February 28).

ENTOMOLOGIST (with a good honours degree and a keen interest in applied entomology), to develop and apply laboratory techniques for investigating the biological activity of insecticides and spray deposits —The Secretary, East Malling Research Station, near Maidstone, Kent (February 28).

SENIOR LECTURER IN MEDICINE at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, February 28).

CONSULTANT BIOMETRICIAN (fully qualified) with the Government of the Federation of Rhodesia and Nyasaland, for duties which include the design of experiments in all phases of agriculture and animal husbandry research and the analysis of data and related statistical practice—The Secretary (R), Rhodesia House, 429 Strand, London, W.C.2 (March 1).

SENIOR LECTURER OR LECTURER IN THE DEPARTMENT OF SURGICAL SCIENCE—The Secretary, The University, Edinburgh (March 1).

LECTURER OR ASSISTANT LECTURER IN THE HISTORY AND PHILOSOPHY OF SCIENCE—The Registrar, The University, Leeds 2 (March 10).

CHAIR OF EDUCATION in the University College of Ghana—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (March 12).

ASSISTANT LECTURER IN ORGANIC CHEMISTRY—The Secretary, The Queen's University, Belfast (March 15).

ASSISTANT LECTURER (with a special interest and qualifications in petrology, and research experience, preferably in either geochemistry, ore mineralogy or structural geology) IN GEOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (March 15).

CHAIR OF GEOLOGY—The Secretary and Registrar, The University, Southampton (March 15).

LECTURER IN AGRICULTURAL ENTOMOLOGY at the University College of Ghana—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (March 15).

LECTURER IN NATURAL PHILOSOPHY—ELECTRONICS—The Secretary, The University, Aberdeen (March 15).

PROFESSOR AND HEAD OF THE DEPARTMENT OF GEOLOGY at the Memorial University of Newfoundland, St. John's, Newfoundland, Canada—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Canada, March 15).

IMMUNOLOGIST (graduate in either science or medicine and with a sound knowledge of immunology) IN THE DEPARTMENT OF SURGICAL SCIENCE, to work on problems of transplantation immunity under the general direction of the Professor—The Secretary, The University, Edinburgh (March 31).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN CHEMISTRY, CIVIL ENGINEERING or PHYSICS—The Registrar, Trinity College, Dublin (March 31).

PROFESSOR OF PREVENTIVE AND SOCIAL MEDICINE at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, March 31).

ASSISTANT, Grade B (with a good honours degree) FOR MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex.

ASSISTANT LECTURER IN METALLURGY IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Royal Technical College, Salford 5.

ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Nottingham.

ASSISTANT (preferably with experience of biochemical or genetic techniques in microbiology) for research on the mode of action of antituberculous drugs—The Secretary, Guy's Hospital Medical School, London Bridge, S.E.1.

ASSISTANT SEISMOLOGIST (with an honours degree in physics or in geology with physics to degree standard, and preferably with research experience in geophysics) at the Imperial College of Tropical Agriculture, Trinidad, British West Indies—The Secretary, I.C.T.A., 40 Norfolk Street, London, W.C.2.

CHEMISTS (with an honours degree), to join a team working on the surface chemistry of carbon and graphite, particularly in relation to the reactivity of these materials with gaseous coolants at elevated temperatures—The Recruitment Officer (1022/34), Atomic Energy Research Establishment, Harwell, Didcot, Berks.

EXPERIMENTAL OFFICER (with a degree in chemistry or agricultural chemistry, or equivalent qualifications), to carry out chemical analyses of soils and plants—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

HARWELL RESEARCH FELLOWS (JUNIOR and SENIOR) (with at least two or three years postgraduate experience), for research in Chemistry, Mathematical Physics, Chemical Engineering, Physics, Metallurgy, Biochemistry and Food Technology—Group Recruitment Officer (1053/2), Atomic Energy Research Establishment, Harwell, Didcot, Berks.

HOSPITAL BIOCHEMIST (Senior grade)—The Group Secretary, Cardiff Hospital Management Committee, 44 Cathedral Road, Cardiff.

PROTEIN CHEMIST or PHYSICIST (preferably Ph.D. or with equivalent research experience), to work on immunological problems—The Secretary, The Wright–Fleming Institute of Microbiology, St. Mary's Hospital Medical School, Paddington, London, W.2.

READER IN WOOL TECHNOLOGY; READER IN MAN-MADE FIBRES AND TEXTILE CHEMISTRY; READER IN HIGH POLYMER CHEMISTRY; READER IN COLOUR CHEMISTRY; READER IN MECHANICAL OR PRODUCTION ENGINEERING; READER IN ELECTRICAL ENGINEERING; and a READER IN PHARMACEUTICS—The Principal, Institute of Technology, Bradford 7.

SCIENTIFIC OFFICER (with a good honours degree in natural science, preferably zoology, with two years postgraduate training or experience in scientific research) IN THE JOINT FISHERIES RESEARCH ORGANIZATION, Northern Rhodesia, to undertake research as may be required into any aspect of freshwater biology, fish and fisheries in Northern Rhodesia and Nyasaland—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.87/3/01.

SENIOR CHEMISTRY MASTER—The Headmaster, Malvern College, Worcs.

SENIOR LECTURER IN MATHEMATICS; SENIOR LECTURER IN PHYSICS; SENIOR LECTURER IN INDUSTRIAL ADMINISTRATION; SENIOR LECTURERS (2) IN PHARMACEUTICS; SENIOR LECTURER IN PHARMACOLOGY; LECTURER IN CHEMICAL ENGINEERING; LECTURERS (2) IN CIVIL ENGINEERING; and a LECTURER IN PHYSICS—The Principal, Institute of Technology, Bradford 7.

VICE-PRINCIPAL (with good academic qualifications and administrative experience, preferably in advanced technological education) —The Principal, Institute of Technology, Bradford 7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institution of Gas Engineers. Publication No. 511: 18th Report of the Chairman's Technical Committee, 1956–57. Pp. 26. Publication No. 512: 34th Report of the Gas Education Committee, 1956–57. Pp. 28. Publication No. 513: The Future of Nuclear Power. By Dr. J. V. Dunworth. Pp. 21. Publication No. 514: The Gas Integrale Plant at Kensal Green. By A. F. Grant and C. H. Lewis. Pp. 38. Publication No. 515: The Use of Light Petroleum Distillate for Gas Making. By E. R. Ward. Pp. 15. Publication No. 516: Eighth Arthur Duckham Research Fellowship Report, 1955–56. By D. Fitzgerald. Pp. 42. Publication No. 517: Investigations Into the Stress-Corrosion Cracking in Welded Gas Plant (Concluding Report). Submitted by the British Welding Research Association. Pp. 16. Publication No. 518: The Sheilhaven-Romford Refinery Gas Pipeline of the North Thames Gas Board. By A. D. L. Copp. Pp. 23. Publication No. 519: Official Programme, 23rd Autumn Research Meeting, London, 19th and 20th November, 1957. Pp. 8. (London: Institution of Gas Engineers, 1957.) [2511

Ageing on the Factory Floor: The Production of Domestic Furniture —an Inquiry made through Works Records and Work Descriptions into the Prospects of Ageing Men within a Mechanized Industry. By F. Le Gros Clark. (Studies of Ageing Within the Conditions of Modern Industry.) Pp. 36. (London: The Nuffield Foundation, 1957.) [2511

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Imperial Institute Commodity Leaflets (New Series). No. 29: Whales and Whaling. Pp. 4. (London: Imperial Institute, 1957.) 4d. [212

Other Countries

Bulletin of the American Museum of Natural History. Vol. 113, Article 5: Natal Plumages and Downy Pteryloses of Passerine Birds of North America. By Prof. David Kenneth Wetherbee. Pp. 339–436 +plates 6 and 7. (New York: American Museum of Natural History, 1957.) 2 dollars. [2511

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United States Department of the Interior: Geological Survey. Water-Supply Paper 1388: Surface Water Supply of the United States, 1955. Part 5: Hudson Bay and Upper Mississippi River Basins. Prepared under the direction of J. V. B. Wells. Pp. xii+548. 1.75 dollars. Water-Supply Paper 1398: Surface Water Supply of the United States, 1955. Part 14: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Prepared under the direction of J. V. B. Wells. Pp. viii+279. 1 dollar. Water-Supply Paper 1413: Geology and Ground-Water Resources of Kitcat County, Washington. By Jack E. Sceva. Pp. vi+178+3 plates. n.p. (Washington, D.C.: Government Printing Office, 1957.) [2511

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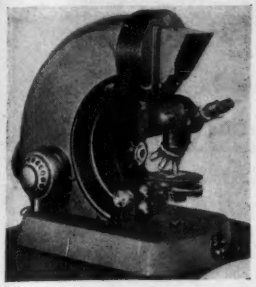

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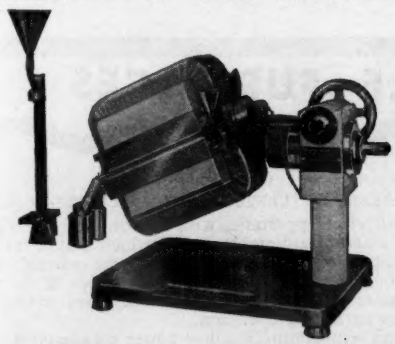

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